DECLARATION

I, the undersigned, of 10-18, Yokoyama, Shimokaiinji, Nagaokakyo-shi, Kyoto, Japan, hereby certify that I am well acquainted with the English and Japanese languages, that I am an experienced translator for patent matter, and that the attached document is a true English translation of

Japanese Patent Application No. **10-60811**

that was filed in Japanese.

I declare that all statements made herein of my own knowledge are true, that all statements on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Signature:

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Dated: **July 12, 2007**

[Name of the Document] Specification

[Title of the Invention] Lead frame, resin-molded semiconductor device, and method for fabricating the same

[Claims]

[Claim 1] A lead frame characterized by comprising:

an outer frame surrounding a region in which a semiconductor chip is mounted;

a die pad formed in the region surrounded by the outer frame;

a support portion for supporting the die pad by connecting the die pad to the outer frame; and

signal-connecting leads connected to the outer frame,

wherein a convex portion protruding downward and a flange portion surrounding the convex portion are formed at the lower surface side of the die pad.

[Claim 2] A lead frame characterized by comprising:

an outer frame surrounding a region in which a semiconductor chip is mounted;

a die pad formed in the region surrounded by the outer frame;

a support portion for supporting the die pad by connecting the die pad to the outer frame; and

signal-connecting leads connected to the outer frame,

wherein the die pad is provided with a hole.

[Claim 3] The lead frame of Claim 2, characterized in

that

the hole of the die pad has a stepped shape, the lower part of the hole being wider in diameter than the upper part thereof.

[Claim 4] A lead frame characterized by comprising:

an outer frame surrounding a region in which a semiconductor chip is mounted;

a die pad formed in the region surrounded by the outer frame;

support leads for supporting the die pad by connecting the die pad to the outer frame; and

signal-connecting leads connected to the outer frame,

wherein the die pad is located below the outer frame.

[Claim 5] The lead frame of Claim 4, characterized in that

the support leads are each bent to function as a spring.

[Claim 6] A lead frame characterized by comprising:

an outer frame surrounding a region in which a semiconductor chip is mounted;

a die pad formed in the region surrounded by the outer frame;

support leads for supporting the die pad by connecting the die pad to the outer frame; and

signal-connecting leads connected to the outer frame,

wherein the die pad is located below the outer frame,

and

wherein the support leads are provided between the signal-connecting leads and the die pad.

[Claim 7] The lead frame of Claim 6, characterized in that

the support leads are each bent to function as a spring.

[Claim 8] The lead frame of Claim 7, characterized in that

the thickness of the bent part of each said support lead is reduced partially at the lowermost section thereof.

[Claim 9] A resin-molded semiconductor device characterized by comprising:

a semiconductor chip having electrode pads;

a die pad for supporting the semiconductor chip thereon;

signal-connecting leads;

connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and

a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members,

wherein a convex portion protruding downward and a flange portion surrounding the convex portion are formed at the lower surface side of the die pad, and

wherein at least lower part of the convex portion of the

die pad is not covered with the resin encapsulant but exposed, whereas the flange portion of the die pad is buried in the resin encapsulant.

[Claim 10] A resin-molded semiconductor device characterized by comprising:

a semiconductor chip having electrode pads;

a die pad for supporting the semiconductor chip thereon;

signal-connecting leads;

connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and

a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members,

wherein lower part of the die pad is at least partially not covered with the resin encapsulant but exposed, and

wherein the die pad is provided with a hole.

[Claim 11] The resin-molded semiconductor device of Claim 10, characterized in that

the hole of the die pad has a stepped shape, the lower part of the hole being wider in diameter than the upper part thereof.

[Claim 12] The resin-molded semiconductor device of Claim 10 or 11, characterized in that

lower part of the die pad protrudes at least partially

from the resin encapsulant.

[Claim 13] A resin-molded semiconductor device characterized by comprising:

a semiconductor chip having electrode pads;

a die pad for supporting the semiconductor chip thereon;

signal-connecting leads;

connecting members for electrically connecting the electrode pads of the semiconductor chip to the leads; and

a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members,

wherein respective lower parts of the die pad and the signal-connecting leads are at least partially not covered with the resin encapsulant but exposed, and

wherein the lower surface of the exposed part of the die pad is located at a level different from those of the lower surfaces of the exposed parts of the signal-connecting leads.

[Claim 14] The resin-molded semiconductor device of Claim 13, characterized in that

the lower surface of the exposed part of the die pad is located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

[Claim 15] The resin-molded semiconductor device of Claim 13 or 14, characterized in that

the level difference between the lower surfaces of the

respective exposed parts of the die pad and the signal-connecting leads are in the range from 10μm to 150μm.

[Claim 16] The resin-molded semiconductor device of any one of Claims 13 to 15, characterized in that

the respective lower parts of the die pad and the signal-connecting leads each protrude at least partially from the resin encapsulant.

[Claim 17] A resin-molded semiconductor device characterized by comprising:

a semiconductor chip having electrode pads;

a die pad for supporting the semiconductor chip thereon;

support leads for supporting the die pad;

signal-connecting leads;

connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and

a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members,

wherein respective lower parts of the die pad and the signal-connecting leads are at least partially not covered with the resin encapsulant but exposed, and

wherein the support leads each extend from an associated corner of the die pad to reach a side face of the resin encapsulant and each partially bent to function as a spring.

[Claim 18] The resin-molded semiconductor device of Claim 17, characterized in that

the lower surface of the exposed part of the die pad is located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

[Claim 19] A resin-molded semiconductor device characterized by comprising:

a semiconductor chip having electrode pads;

a die pad for supporting the semiconductor chip thereon;

support leads for supporting the die pad;

signal-connecting leads;

connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and

a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members,

wherein respective lower parts of the die pad and the signal-connecting leads are at least partially not covered with the resin encapsulant but exposed, and

wherein the support leads are provided between the die pad and the signal-connecting leads.

[Claim 20] The resin-molded semiconductor device of Claim 19, characterized in that

the support leads are each partially bent to function as

a spring.

[Claim 21] The resin-molded semiconductor device of Claim 20, characterized in that

the support leads are each partially cut off.

[Claim 22] The resin-molded semiconductor device of Claim 21, characterized in that

a portion surrounding the cut part of each said support lead is thinner than the other parts of the support lead.

[Claim 23] The resin-molded semiconductor device of any one of Claims 19 to 22, characterized in that

the lower surface of the exposed part of the die pad is located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

[Claim 24] The resin-molded semiconductor device of any one of Claims 9 to 23, characterized in that

a groove portion is formed in at least part of each said signal-connecting lead.

[Claim 25] A method for manufacturing a resin-molded semiconductor device, characterized by comprising:

a first step of preparing a lead frame, the lead frame including: an outer frame surrounding a region in which a semiconductor chip is mounted; a die pad for supporting the semiconductor chip thereon; support leads for connecting the die pad to the outer frame; and signal-connecting leads to be connected to the outer frame, the die pad being located below

the signal-connecting leads;

a second step of mounting the semiconductor chip, including electrode pads, onto the die pad;

a third step of electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads with metal fine wires;

a fourth step of attaching a seal tape to a die assembly for encapsulation while adhering the seal tape at least partially to the respective lower surfaces of the die pad and the signal-connecting leads of the lead frame;

a fifth step of encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the metal fine wires with a resin encapsulant; and

a sixth step of removing the seal tape,

wherein resin encapsulation is realized such that the respective lower surfaces of the die pad and the signal-connecting leads are at least partially not covered with the back surface of the resin encapsulant but exposed, and that the lower surface of the exposed part of the die pad is located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

[Claim 26] A method for manufacturing a resin-molded semiconductor device, characterized by comprising:

a first step of preparing a lead frame, the lead frame including: an outer frame surrounding a region in which a

semiconductor chip is mounted; a die pad for supporting the semiconductor chip thereon; signal-connecting leads to be connected to the outer frame; and support leads interposed between the die pad and the signal-connecting leads;

a second step of mounting the semiconductor chip, including electrode pads, onto the die pad;

a third step of electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads with metal fine wires;

a fourth step of attaching a seal tape to a die assembly for encapsulation while adhering the seal tape at least partially to the respective lower surfaces of the die pad and the signal-connecting leads of the lead frame;

a fifth step of encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the metal fine wires with a resin encapsulant;

a sixth step of cutting off part of the support leads; and

a seventh step of removing the seal tape,

wherein resin encapsulation is realized such that the respective lower surfaces of the die pad and the signal-connecting leads are at least partially not covered with the back surface of the resin encapsulant but exposed.

[Claim 27] The manufacturing method of a resin-molded semiconductor device according to Claim 25 or 26,

characterized in that

in the first step, a lead frame having a metal plated layer formed on the surface thereof is prepared.

[Claim 28] The manufacturing method of a resin-molded semiconductor device according to Claim 25 or 26, characterized in that

in the fourth step, a seal tape with a predetermined thickness is used such that at least part of the respective lower surfaces of the die pad and the signal-connecting leads protrude from the back surface of the resin encapsulant to reach respective desired heights.

[Claim 29] The manufacturing method of a resin-molded semiconductor device according to Claim 25 or 26, characterized in that:

clearance grooves are formed in respective regions of the die assembly for encapsulation which face the die pad and portions of the signal-connecting leads which should be protruded; and

in the fifth step, resin encapsulation is performed while making at least part of the respective lower surfaces of the die pad and the signal-connecting leads enter the clearance grooves, thereby adjusting the respective heights of the portions protruding from the back surface of the resin encapsulant.

[Claim 30] A method for manufacturing a resin-molded

semiconductor device, characterized by comprising:

a first step of preparing a die assembly for encapsulation having a suction hole, a semiconductor chip, and a peripheral member for the semiconductor chip;

a second step of attaching a seal tape to between the peripheral member and the die assembly for encapsulation such that the seal tape adheres to part of a surface of the peripheral member;

a third step of forming a hole in part of the seal tape adhered to the peripheral member;

a fourth step of sucking part of the peripheral member through the suction hole of the die assembly for encapsulation and the hole of the tape;

a fifth step of encapsulating the semiconductor chip and the peripheral member except for at least the part of the surface thereof in a resin encapsulant, with the seal tape adhered to the surface; and

a sixth step of removing the seal tape after the third step has been performed,

wherein after the fourth step is finished, at least part of the surface of the peripheral member protrudes and is not covered with the resin encapsulant but exposed.

[Claim 31] The manufacturing method of a resin-molded semiconductor device according to Claim 30, characterized in that:

in the first step, a lead frame having a die pad is prepared as the peripheral member of the semiconductor chip; and

the part of the surface of the peripheral member in the second step is the die pad of the lead frame.

[Claim 32] A method for manufacturing a resin-molded semiconductor device, characterized by comprising:

a first step of preparing a die assembly for encapsulation, a semiconductor chip, and a peripheral member for the semiconductor chip;

a second step of attaching a seal tape to between the peripheral member and the die assembly for encapsulation such that the seal tape adheres to part of a surface of the peripheral member, the thickness of the seal tape being in the range from 10μm to 150μm;

a third step of encapsulating the semiconductor chip and the peripheral member except for at least the part of the surface thereof in a resin encapsulant, with the seal tape adhered to the surface; and

a fourth step of removing the seal tape after the third step has been performed,

wherein after the fourth step is finished, at least part of the surface of the peripheral member protrudes and is not covered with the resin encapsulant but exposed.

[Detailed Description of the Invention]

[Technical Field to which the Invention Belongs]

The present invention relates to a resin-molded semiconductor device in which a semiconductor chip and signal-connecting leads to be connected to the semiconductor chip are encapsulated with a resin encapsulant, a method for manufacturing such a device, and a lead frame suitable for manufacturing the resin-molded semiconductor device, and the present invention relates to, in particular, the improvement of a resin-molded semiconductor device with a reduced thickness.

[Prior Art]

In recent years, in order to catch up with advancing downsizing of electronic appliances, it has become necessary to mount, with higher and higher density, semiconductor components to be built in electronic appliances, and sizes and thicknesses of semiconductor components have also been reduced correspondingly.

Hereinafter, a conventional resin-molded semiconductor device will be described.

FIG. **20** is a cross-sectional view of a conventional resin-molded semiconductor device. As shown in FIG. **20**, the conventional resin-molded semiconductor device is the resin-molded semiconductor device of the type that includes external electrodes on its back surface.

The conventional resin-molded semiconductor device

further includes a lead frame including: inner leads **101**; a die pad **102**; and support leads (not shown) for supporting the die pad **102**. Further, a semiconductor chip **104** is bonded onto the die pad **102** with an adhesive, and electrode pads (not shown) of the semiconductor chip **104** are electrically connected to the inner leads **101** with metal fine wires **105**. Furthermore, the die pad **102**, semiconductor chip **104**, part of the inner leads **101**, support leads, and metal fine wires **105** are encapsulated with a resin encapsulant **106**. In this structure, no resin encapsulant **106** exists on the back surface sides of the inner leads **101**, that is, the inner leads **101** are exposed at the back surface sides thereof and the lower parts of the inner leads **101**, including the exposed surfaces thereof, are used as external electrodes **107**. It should be noted that, to ensure the adhesion between the resin encapsulant **106** and the inner leads **101** or the die pad **102**, the side faces of the inner leads **101** and the die pad **102** are each formed like a taper with an upwardly increasing thickness, not to extend perpendicularly to their upper and lower surfaces.

In such a resin-molded semiconductor device, the respective back surfaces of the resin encapsulant **106** and the die pad **102** are both located on the same plane. Stated otherwise, since the back surface of the lead frame is not substantially encapsulated, a thin resin-molded semiconductor

device is implemented.

In the manufacturing process of a resin-molded semiconductor device having such a structure as that shown in FIG. **20**, first, a lead frame including inner leads **101** and a die pad **102** is prepared and then wrought mechanically or chemically to shape the side faces of the lead frame like a taper. Next, a semiconductor chip **104** is bonded onto the die pad **102** of the lead frame prepared, and then the semiconductor chip **104** is electrically connected to the inner leads **101** with metal fine wires **105**. As the metal fine wire **105**, an aluminum fine wire, a gold (Au) wire, or the like may be appropriately used. Then, the die pad **102**, semiconductor chip **104**, inner leads **101**, support leads, and metal fine wires **105** are encapsulated with a resin encapsulant **106**. In this case, the lead frame, on which the semiconductor chip **104** has been bonded, is introduced into a die assembly for encapsulation and transfer-molded, and in particular, resin encapsulation is performed with the back surface of the lead frame in contact with an upper or lower die of the die assembly for encapsulation. Finally, after the resin encapsulation has been performed, outer leads, protruding outward from the resin encapsulant **106**, are cut off, thereby completing a resin-molded semiconductor device.

[Problems that the Invention is to solve]

However, although the above conventional resin-molded

semiconductor device with a smaller thickness is implementable, the device has the following problems.

Firstly, a resin encapsulant exists over the upper and side faces of a die pad, but does not exist on the back surface side thereof. Accordingly, the force of the resin encapsulant holding the die pad and the semiconductor chip is decreased, thus causing the problem of the deterioration in reliability of the device.

Secondly, the conventional resin-molded semiconductor device also has the problems that stress applied by the resin encapsulant or stress applied after assembling might have unwanted effects on a semiconductor chip and that a crack might be created in the resin encapsulant. Particularly when moisture penetrates between the die pad and the resin encapsulant, the adhesion therebetween decreases to a noticeable degree or considerable cracking is created. As a result, there arises another problem that the reliability of the device further deteriorates.

Thirdly, when a resin-molded semiconductor device is mounted on a motherboard, the position of the resin-molded semiconductor device to be mounted on the motherboard can be determined accurately by a self-alignment technique using the tension of solder, but reduction in time of the mounting by shortening the time taken to settle the self alignment is still to be furthered and the mounting accuracy is still to

be improved.

Fourthly, if part of a resin encapsulant sticks out of the back surface of a die pad in bonding the die pad and a motherboard (i.e., if so-called resin burr exists), the die pad cannot be in satisfactory contact with a heat-radiating pad, for example; therefore, desired characteristics such as heat radiation characteristics might not be attained sufficiently. Meanwhile, such resin burr can be removed by using water jet or the like, but such a process is not only troublesome but also leads to deterioration in work efficiency and reliability of the device for the following reason: if a water jet process is carried out, then a nickel, palladium or gold plated layer might peel off and impurity might deposit on the exposed parts, and as a consequence such parts, not covered with the resin encapsulant but exposed, should be plated once again after the resin encapsulation process has been performed.

The present invention has been made in view of the above points and has the following objects.

A first object of this invention is providing a resin-molded semiconductor device capable of suppressing delamination of a die pad by taking measures to make a resin encapsulant hold the die pad more strongly when the lower surface of the die pad is not covered with the resin encapsulant but exposed, and a lead frame suitable for

manufacturing such a device.

A second object of this invention is providing a resin-molded semiconductor device capable of preventing a resin encapsulant from cracking due to penetration of water or moisture between a die pad and the resin encapsulant, and a lead frame suitable for manufacturing such a device.

A third object of this invention is providing a resin-molded semiconductor device that has the function of being self-aligned accurately on a motherboard by using a structure where the lower surface of a die pad is not covered with the resin encapsulant but exposed, and a method for manufacturing the same.

A fourth object of this invention is providing a resin-molded semiconductor device with heat radiation characteristics improved by taking measures to prevent the formation of resin burr where the lower surface of a die pad is not covered with the resin encapsulant but exposed, a manufacturing method thereof, and a lead frame suitable for manufacturing such a device.

Further, a fifth object of this invention is providing a resin-molded semiconductor device in which solder balls need not be interposed between a die pad and a heat-radiating pad, and a method for manufacturing the same.

[Means for Solving the Problems]

To achieve each of the above objects, the present

invention takes measures for first through fourth lead frames, first through fifth resin-molded semiconductor devices, and first through fourth methods for manufacturing a resin-molded semiconductor device.

As recited in Claim 1, a first lead frame according to the present invention includes: an outer frame surrounding a region in which a semiconductor chip is mounted; a die pad formed in the region surrounded by the outer frame; a support portion for supporting the die pad by connecting the die pad to the outer frame; signal-connecting leads connected to the outer frame, wherein a convex portion protruding downward and a flange portion surrounding the convex portion are formed at the lower surface side of the die pad.

In this structure, even if the lower surface of the convex portion of the die pad is not covered with the resin encapsulant but exposed in mounting a semiconductor chip on this lead frame and performing resin encapsulation, it is possible to make the resin encapsulant exist under the flange portion of the die pad, thereby obtaining a resin-molded semiconductor device where a resin encapsulant can hold the die pad more strongly. That is to say, the first object is accomplished. In addition, since the adhesion between the resin encapsulant and the die pad increases, penetration of water or moisture through the boundary between the resin encapsulant and the die pad can be suppressed. Consequently,

the second object, or increase in moisture resistance, is also achieved.

As recited in Claim 2, a second lead frame according to the present invention includes: an outer frame surrounding a region in which a semiconductor chip is mounted; a die pad formed in the region surrounded by the outer frame; a support portion for supporting the die pad by connecting the die pad to the outer frame; and signal-connecting leads connected to the outer frame, wherein the die pad is provided with a hole.

In this structure, when a semiconductor chip is mounted onto this lead frame and resin encapsulation is performed, the resin encapsulant also exists inside the hole, resulting in increase in force of the resin encapsulant holding the die pad. Accordingly, the first and second objects are accomplished.

As recited in Claim 3, in the second lead frame, the hole of the die pad preferably has a stepped shape, the lower part of the hole being preferably wider in diameter than the upper part thereof.

In such a structure, it is possible to remarkably attain not only the effect of increasing the force with which the resin encapsulant holds the die pad, but also the effect of increasing the moisture resistance of the device.

As recited in Claim 4, a third lead frame according to the present invention includes: an outer frame surrounding a

region in which a semiconductor chip is mounted; a die pad formed in the region surrounded by the outer frame; support leads for supporting the die pad by connecting the die pad to the outer frame; and signal-connecting leads connected to the outer frame, wherein the die pad is located below the outer frame.

In this structure, when a semiconductor chip is mounted onto this lead frame and resin encapsulation is performed, a clamping force, applied through a die assembly for encapsulation onto the outer frame, is efficiently applied to the die pad; therefore, when resin encapsulation is performed, for example, with a seal tape adhered to the lower surface of the lead frame, it is possible to obtain the function of the die pad being forced into the seal tape, thus making this lead frame suitable for protruding the die pad downward from the back surface of the resin encapsulant. In other words, since a standoff height is secured, solder balls or the like no longer need to be provided in the portion where the die pad and a motherboard are bonded, thus accomplishing the fifth object.

As recited in Claim 5, in the third lead frame, the support leads are each preferably bent to function as a spring.

In such a structure, since deformation of the support lead is absorbed at its bent portion, deformation of the die

pad due to pressure can be suppressed.

As recited in Claim 6, a fourth lead frame according to the present invention includes: an outer frame surrounding a region in which a semiconductor chip is mounted; a die pad formed in the region surrounded by the outer frame; support leads for supporting the die pad by connecting the die pad to the outer frame; and signal-connecting leads connected to the outer frame, wherein the die pad is located below the outer frame, and the support leads are provided between the signal-connecting leads and the die pad.

In this structure, when a semiconductor chip is mounted onto this lead frame and resin encapsulation is performed, a clamping force, applied through a die assembly for encapsulation onto the outer frame, can be transmitted to the die pad even more efficiently, thus attaining the same effects as those of the third lead frame.

As recited in Claim 7, in the fourth lead frame, the support leads are each preferably bent to function as a spring.

As recited in Claim 8, in the fourth lead frame, the thickness of the bent part of each said support lead is preferably reduced partially at the lowermost section thereof.

In such a structure, after a semiconductor chip has been mounted onto this lead frame and resin encapsulation has been

performed, the signal-connecting leads connected to the support leads can be cut off more easily.

As recited in Claim 9, a first resin-molded semiconductor device according to the present invention includes: a semiconductor chip having electrode pads; a die pad for supporting the semiconductor chip thereon; signal-connecting leads; connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members, wherein a convex portion protruding downward and a flange portion surrounding the convex portion are formed at the lower surface side of the die pad, and at least lower part of the convex portion of the die pad is not covered with the resin encapsulant but exposed, whereas the flange portion of the die pad is buried in the resin encapsulant.

In this structure, since the resin encapsulant exists under the flange portion of the die pad, the resin encapsulant can hold the die pad more strongly and the first object is accomplished. In addition, since the effect of suppressing the penetration of water or moisture through the back surface of the resin-molded semiconductor device can also be attained as described above, the second object is achieved as well.

As recited in Claim 10, a second resin-molded semiconductor device according to the present invention includes: a semiconductor chip having electrode pads; a die pad for supporting the semiconductor chip thereon; signal-connecting leads; connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members, wherein lower part of the die pad is at least partially not covered with the resin encapsulant but exposed, and the die pad is provided with a hole.

In this structure, since the resin encapsulant exists inside the hole of the die pad, the resin encapsulant can hold the die pad even more strongly, thus accomplishing the first and second objects.

As recited in Claim 11, in the second resin-molded semiconductor device, the hole of the die pad preferably has a stepped shape, the lower part of the hole preferably being wider in diameter than the upper part thereof.

In such a structure, it is possible to remarkably attain not only the effect of increasing the force of the resin encapsulant holding the die pad, but also the effect of increasing the moisture resistance of the device.

As recited in Claim 12, in the second resin-molded

semiconductor device, lower part of the die pad preferably protrudes at least partially from the resin encapsulant.

Thus, the resin-molded semiconductor device can have a structure obtained by adhering a seal tape to the lower surface of the die pad and forcing the die pad into the seal tape in the resin encapsulation during manufacturing the resin-molded semiconductor device. Accordingly, in such a structure, no resin encapsulant sticks out of the hole on the lower surface of the die pad, thus obtaining a resin-molded semiconductor device excellent in heat radiating characteristics, for example, where no resin burr exists on the lower surface of the die pad thereof.

As recited in Claim 13, a third resin-molded semiconductor device according to the present invention includes: a semiconductor chip having electrode pads; a die pad for supporting the semiconductor chip thereon; signal-connecting leads; connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members, wherein respective lower parts of the die pad and the signal-connecting leads are at least partially not covered with the resin encapsulant but exposed, and the lower surface of the exposed part of the die pad is located at a level different

from those of the lower surfaces of the exposed parts of the signal-connecting leads.

In this structure, when such a resin-molded semiconductor device is mounted onto a motherboard, the gap between the die pad and the motherboard is different in height from the gap between the signal-connecting leads and the motherboard; therefore, the tension of solder interposed therebetween also differs between these two points, and the self alignment of the device is improved. That is to say, the time taken to realize good self-alignment can be shortened and the positional accuracy can also be improved.

As recited in Claim 14, in the third resin-molded semiconductor device, the lower surface of the exposed part of the die pad is preferably located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

As recited in Claim 15, in the third resin-molded semiconductor device, the level difference between the lower surfaces of the respective exposed parts of the die pad and the signal-connecting leads is preferably in the range from 10 μm to 150μm.

As recited in Claim 16, in the third resin-molded semiconductor device, the respective lower parts of the die pad and the signal-connecting leads each preferably protrude at least partially from the resin encapsulant.

As recited in Claim 17, a fourth resin-molded semiconductor device according to the present invention includes: a semiconductor chip having electrode pads; a die pad for supporting the semiconductor chip thereon; support leads for supporting the die pad; signal-connecting leads; connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members, wherein respective lower parts of the die pad and the signal-connecting leads are at least partially not covered with the resin encapsulant but exposed, and the support leads each extend from an associated corner of the die pad to reach a side face of the resin encapsulant and each partially bent to function as a spring.

In this structure, during resin encapsulation using a lead frame where a die pad is located below an outer frame, a clamping force, applied through a die assembly for encapsulation to the outer frame, can be transmitted to the die pad, while making the bent portions suppress the deformation of the support leads. Accordingly, when resin encapsulation is performed, for example, with a seal tape adhered to the lower surface of the lead frame, the die pad is forced into the seal tape, thus making it possible to obtain, with more certainty, a structure in which the die pad

protrudes downward from the back surface of the resin encapsulant and to suppress the deformation of the die pad. As a result, the fifth object is accomplished while keeping the shape of the resin-molded semiconductor device good enough.

As recited in Claim 18, in the fourth resin-molded semiconductor device, the lower surface of the exposed part of the die pad is preferably located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

As recited in Claim 19, a fifth resin-molded semiconductor device according to the present invention includes: a semiconductor chip having electrode pads; a die pad for supporting the semiconductor chip thereon; support leads for supporting the die pad; signal-connecting leads; connecting members for electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads; and a resin encapsulant for encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the connecting members, wherein respective lower parts of the die pad and the signal-connecting leads are at least partially not covered with the resin encapsulant but exposed, and the support leads are provided between the die pad and the signal-connecting leads.

In this structure, when resin encapsulation is performed

during the manufacturing process of this resin-molded semiconductor device, a clamping force, applied through a die assembly for encapsulation to the outer frame, can be transmitted to the die pad with more certainty, and as a consequence the same effects as those of the fourth resin-molded semiconductor device can be attained.

As recited in Claim 20, in the fifth resin-molded semiconductor device, the support leads are each preferably bent partially to function as a spring.

As recited in Claim 21, in the fifth resin-molded semiconductor device, the support leads are each preferably cut off partially.

In such a structure, the signal-connecting leads, which were connected to the support leads, can be used for signal connection irrespective of the type of the semiconductor chip.

As recited in Claim 22, in the fifth resin-molded semiconductor device, a portion surrounding the cut part of each said support lead is preferably thinner than the other parts of the support lead.

In such a structure, the support leads can be cut off more easily.

As recited in Claim 23, in the fifth resin-molded semiconductor device, the lower surface of the exposed part of the die pad is preferably located at a level lower than the lower surfaces of the exposed parts of the signal-connecting

leads.

As recited in Claim 24, in the first to fifth resin-molded semiconductor devices, a groove portion is preferably formed in at least part of each said signal-connecting lead.

In such a structure, even if the lower surfaces of the signal-connecting leads are not covered with the resin encapsulant but exposed, the force of the resin encapsulant holding the signal-connecting leads improves.

As recited in Claim 25, a first method for manufacturing a resin-molded semiconductor device according to the present invention includes: a first step of preparing a lead frame, the lead frame including: an outer frame surrounding a region in which a semiconductor chip is mounted; a die pad for supporting the semiconductor chip thereon; support leads for connecting the die pad to the outer frame; and signal-connecting leads to be connected to the outer frame, the die pad being located below the signal-connecting leads; a second step of mounting the semiconductor chip, including electrode pads, onto the die pad; a third step of electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads with metal fine wires; a fourth step of attaching a seal tape to a die assembly for encapsulation while adhering the seal tape at least partially to the respective lower surfaces of the die pad and the signal-connecting leads of the lead frame; a fifth step of

encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the metal fine wires with a resin encapsulant; and a sixth step of removing the seal tape, wherein the resin encapsulation is realized such that the respective lower surfaces of the die pad and the signal-connecting leads are at least partially not covered with the back surface of the resin encapsulant but exposed, and that the lower surface of the exposed part of the die pad is located at a level lower than the lower surfaces of the exposed parts of the signal-connecting leads.

When a resin-molded semiconductor device is mounted onto a motherboard in accordance with this method, the large tension of solder or the like under the die pad regulates the self alignment of the resin-molded semiconductor device in terms of the position defined and the time taken. Accordingly, the device can be mounted not only in a shorter time but also at a desired position with higher accuracy, i.e., the device increases its mountability. That is to say, the third object is accomplished.

As recited in Claim 26, a second method for manufacturing a resin-molded semiconductor device according to the present invention includes: a first step of preparing a lead frame, the lead frame including: an outer frame surrounding a region in which a semiconductor chip is mounted; a die pad for supporting the semiconductor chip thereon; signal-connecting

leads to be connected to the outer frame; and support leads interposed between the die pad and the signal-connecting leads; a second step of mounting the semiconductor chip, including electrode pads, onto the die pad; a third step of electrically connecting the electrode pads of the semiconductor chip to the signal-connecting leads with metal fine wires; a fourth step of attaching a seal tape to a die assembly for encapsulation while adhering the seal tape at least partially to the respective lower surfaces of the die pad and the signal-connecting leads of the lead frame; a fifth step of encapsulating the die pad, the semiconductor chip, the signal-connecting leads, and the metal fine wires with a resin encapsulant; a sixth step of cutting off part of the support leads; and a seventh step of removing the seal tape, wherein the resin encapsulation is realized such that the respective lower surfaces of the die pad and the signal-connecting leads are at least partially not covered with the back surface of the resin encapsulant but exposed.

In accordance with this method, a clamping force, applied onto the outer frame of the lead frame, can be efficiently transmitted to the die pad through the support leads in the fifth step, thus obtaining, with more certainty, a structure in which the die pad protrudes from the resin encapsulant. In addition, since the signal-connecting leads, which were connected to the support leads, are cut off from

the die pad in the sixth step, the signal-connecting leads can be used for signal connection irrespective of the type of the semiconductor chip mounted. That is to say, the fifth object is accomplished.

As recited in Claim 27, in the first or second method for manufacturing a resin-molded semiconductor device, a lead frame having a metal plated layer formed on the surface thereof is preferably prepared in the first step.

In accordance with such a method, in addition to making the work of a plating process simpler as compared with a method in which only parts not covered with a resin encapsulant but exposed are plated after the resin encapsulation, the reliability of the resin-molded semiconductor device is improved because the lead frame buried in the resin encapsulant is also plated.

As recited in Claim 28, in the first or second method for manufacturing a resin-molded semiconductor device, a seal tape with a predetermined thickness is preferably used in the fourth step such that at least part of the respective lower surfaces of the die pad and the signal-connecting leads protrude from the back surface of the resin encapsulant to reach respective desired heights.

In accordance with such a method, the height of the part of the die pad protruding from the resin encapsulant can be adjusted at a desired value.

As recited in Claim 29, in the first or second method for manufacturing a resin-molded semiconductor device, clearance grooves are formed in respective regions of the die assembly for encapsulation which face the die pad and portions of the signal-connecting leads which should be protruded, and in the fifth step, resin encapsulation is performed while making at least part of the respective lower surfaces of the die pad and the signal-connecting leads enter the clearance grooves, thereby adjusting the respective heights of the portions protruding from the back surface of the resin encapsulant.

As recited in Claim 30, a third method for manufacturing a resin-molded semiconductor device according to the present invention includes: a first step of preparing a die assembly for encapsulation having a suction hole, a semiconductor chip, and a peripheral member for the semiconductor chip; a second step of attaching a seal tape to between the peripheral member and the die assembly for encapsulation such that the seal tape adheres to part of a surface of the peripheral member; a third step of forming a hole in part of the seal tape adhered to the peripheral member; a fourth step of sucking part of the peripheral member through the suction hole of the die assembly for encapsulation and the hole of the tape; a fifth step of encapsulating the semiconductor chip and the peripheral member except for at least the part

of the surface thereof in a resin encapsulant, with the seal tape adhered to the surface; and a sixth step of removing the seal tape after the third step has been performed, wherein after the fourth step is finished, at least part of the surface of the peripheral member protrudes and is not covered with the resin encapsulant but exposed.

In accordance with this method, part of the peripheral member is forced into the seal tape as the member has been sucked through the suction hole of the die assembly for encapsulation in the fourth step: therefore, a resin-molded semiconductor device, in which part of the peripheral member protrudes without fail from the resin encapsulant after the resin encapsulation process, can be obtained. That is to say, the fifth object is accomplished.

As recited in Claim 31, in the third method for manufacturing a resin-molded semiconductor device, a lead frame having a die pad may be prepared in the first step as the peripheral member of the semiconductor chip, and the part of the surface of the peripheral member in the second step may be the die pad of the lead frame.

As recited in Claim 32, a fourth method for manufacturing a resin-molded semiconductor device according to the present invention includes: a first step of preparing a die assembly for encapsulation, a semiconductor chip, and a peripheral member for the semiconductor chip; a second step

of attaching a seal tape to between the peripheral member and the die assembly for encapsulation such that the seal tape adheres to part of a surface of the peripheral member, the thickness of the seal tape being in the range from 10 μm to 150 μm; a third step of encapsulating the semiconductor chip and the peripheral member except for at least the part of the surface thereof in a resin encapsulant, with the seal tape adhered to the surface; and a fourth step of removing the seal tape after the third step has been performed, wherein after the fourth step is finished, at least part of the surface of the peripheral member protrudes and is not covered with the resin encapsulant but exposed.

In accordance with this method, a resin-molded semiconductor device, in which part of the peripheral member protrudes from the resin encapsulant after the resin encapsulation process, is obtained, thus accomplishing the fifth object.

[Embodiments of the Invention]

Each of the resin-molded semiconductor devices of the present invention has the same structure in which the lower surface of a die pad is not covered with the back surface of a resin encapsulant but exposed, and various embodiments of the present invention will be described below.

(FIRST EMBODIMENT)

FIG. **1** is a cross-sectional view of a resin-molded semiconductor device according to the first embodiment. It is to be noted that, in FIG. **1**, a resin encapsulant **17** is illustrated as being transparent and support leads are omitted in the drawings.

As shown in FIG. **1**, the resin-molded semiconductor device of this embodiment includes a lead frame including: signal-connecting leads **12**; a die pad **13** for supporting a semiconductor chip thereon; and support leads for supporting the die pad **13**. Further, the semiconductor chip **15** is bonded on the die pad **13** with an adhesive, and electrode pads (not shown) of the semiconductor chip **15** are electrically connected to the signal-connecting leads **12** with metal fine wires **16**. Furthermore, the signal-connecting leads **12**, die pad **13**, support leads, semiconductor chip **15**, and metal fine wires **16** are encapsulated within a resin encapsulant **17**.

Now, this embodiment is characterized in that the back surface side of the die pad **13** has a stepped shape by half etching or the like so as to include a convex portion **13a** at the center thereof and a flange portion **13b** surrounding the convex portion **13a**, and that only lower part of the convex portion **13a** protrudes from the back surface of the resin encapsulant. Accordingly, in the state where the chip, frame and so on have been encapsulated with the resin encapsulant **17**, the resin encapsulant **17** thinly exists under the flange

portion **13b** surrounding the convex portion **13a** of the die pad **13**.

Also, no resin encapsulant **17** exists on the lower surface sides of the signal-connecting leads **12**, that is, the lower surfaces of the signal-connecting leads **12** are exposed, and are used as interconnection with a motherboard. That is to say, the lower parts of the signal-connecting leads **12** function as external electrodes **18**.

Moreover, no resin burr, which ordinarily sticks out during the resin encapsulation step, exists on the exposed convex portion **13a** of the die pad **13** and on the external electrodes **18**, and the convex portion **13a** of the die pad **13** and the external electrodes **18** slightly protrude downward from the back surface of the resin encapsulant **17**. Such a structure in which the convex portion **13a** of the die pad **13** and the external electrodes **18** protrude downward so as to have no resin burr thereon is easily realized by the manufacturing process described later.

In the resin-molded semiconductor device of this embodiment, the back surface side of the die pad **13** has a stepped shape including the convex portion **13a** at its center and only lower part of the convex portion **13a** is not covered with the resin encapsulant but exposed; therefore, the resin encapsulant **17** thinly exists under the flange portion **13b** of the die pad **13**. As a result, the force of the resin

encapsulant **17** holding the die pad **13** is increased, thus improving the reliability of the resin-molded semiconductor device.

Also, since the holding force increases, the adhesion between the resin encapsulant **17** and the die pad **13** also increases, which prevents the penetration of water or moisture through the boundary therebetween, resulting in increase of moisture resistance of the device. Consequently, the reliability of the resin-molded semiconductor device further improves.

Moreover, no resin burr exists on the lower surface of the exposed convex portion **13a** of the die pad **13**, thus improving the reliability of bonding between the convex portion **13a** and the motherboard and heat radiating characteristics.

It should be noted that, in this embodiment, no outer leads, functioning as external electrode terminals, exist around the signal-connecting leads **12**, but the lower parts of the signal-connecting leads **12**, corresponding to inner leads, function as the external electrodes **18**, thus enabling downsizing of a semiconductor device. Moreover, since no resin burr exists on the lower surfaces of the signal-connecting leads **12**, i.e., the lower surfaces of the external electrodes **18**, electrodes of the motherboard can be bonded to the external electrodes **18** with more reliability.

Furthermore, since the external electrodes **18** are formed to protrude from the surface of the resin encapsulant **17**, a standoff height has been secured in advance for the external electrodes **18** in bonding the external electrodes to the electrodes of the motherboard during mounting of a resin-molded semiconductor device on the motherboard. Accordingly, the external electrodes **18** can be used as external terminals as they are, and there is no need to attach solder balls or the like to the external electrodes **18** during mounting of the device on the motherboard, thus advantageously reducing number of process steps and manufacturing cost.

Next, a method for manufacturing the resin-molded semiconductor device of this embodiment will be described with reference to the drawings. FIGS. **2** through **6** are cross-sectional views illustrating respective process steps for manufacturing the resin-molded semiconductor device of this embodiment.

First, in the process step shown in FIG. **2**, a lead frame **20** provided with signal-connecting leads **12** and a die pad **13** for supporting a semiconductor chip thereon is prepared. Although the die pad **13** is actually supported by support leads, the support leads are not illustrated in FIG. **2** because the support leads do not appear in this cross section. Also, the outer periphery of the signal-connecting leads **12** is connected to an outer frame of the lead frame **20**,

but the boundary between the signal-connecting leads and the outer frame does not appear in this cross section, because the outer frame is continuous with the signal-connecting leads. In this case, the back surface side of the die pad **13** is formed to have a stepped shape by performing half etching with the center portion masked such that a convex portion **13a** is formed in its center and a flange portion **13b** exists around the convex portion **13a**. Further, the lead frame **20** prepared is not provided with tie bars used for stopping the outflow of a resin encapsulant during resin encapsulation.

Also, the lead frame **20** of this embodiment is formed by plating a frame made of copper (Cu) with the three metal layers of: an undercoat nickel (Ni) layer; a palladium (Pd) layer deposited on the nickel (Ni) layer; and an outermost thin gold (Au) layer. It is to be noted that the lead frame **20** may be made of any raw material other than copper (Cu), e.g., 42 alloy member. Also, the lead frame **20** may be plated with any noble metals other than nickel (Ni), palladium (Pd) and gold (Au). Furthermore, the lead frame **20** is not necessarily plated with three layers.

Next, in the process step shown in FIG. **3**, a semiconductor chip **15** is mounted and bonded, with an adhesive, onto the die pad of the lead frame prepared. This process step is so-called "die bonding". It should be noted that a member for supporting the semiconductor chip is not

limited to a lead frame. Alternatively, any other member, such as a TAB tape or a substrate, that can support the semiconductor chip may also be used.

Then, in the process step shown in FIG. **4**, the semiconductor chip **15**, bonded to the die pad **13**, is electrically connected to the signal-connecting leads **12** with metal fine wires **16**. This process step is so-called "wire bonding". As the metal fine wire, an aluminum fine wire, a gold (Au) wire, or the like may appropriately be selected and used. Optionally, the semiconductor chip **15** may be electrically connected to the signal-connecting leads **12** via bumps or the like, instead of the metal fine wires **16**.

Subsequently, in the process step shown in FIG. **5**, a seal tape **21** is attached to the lower surface of the convex portion of the die pad **13** and the back surfaces of the signal-connecting leads **12** with the semiconductor chip **15** bonded onto the die pad **13** of the lead frame.

The seal tape **21** is provided so that it virtually functions as a mask for preventing the resin encapsulant from reaching, in particular, the lower surface side of the convex portion **13a** of the die pad **13** and the back surface sides of the signal-connecting leads **12** during resin encapsulation, and the existence of the seal tape **21** can prevent resin burr from being formed on the lower surface of the convex portion **13a** of the die pad **13** and the back surfaces of the signal-

connecting leads **12**. The seal tape **21** may be any resin-based tape, which is mainly composed of polyethylene terephthalate, polyimide, polycarbonate or the like, can be easily peeled off after the resin encapsulation, and preferably has some resistance to an elevated-temperature environment during the resin encapsulation. In this embodiment, a tape mainly composed of polyethylene terephthalate is used and the thickness thereof is set at 50μm.

Then, in the process step shown in FIG. **6**, the lead frame, in which the semiconductor chip **15** has been bonded and to which the seal tape **21** has been attached, is introduced into a die assembly, and then a resin encapsulant **17** is poured into the die assembly to perform resin encapsulation. Alternatively, the seal tape **21** may be attached beforehand to the inner face of the die assembly. In such a case, the chip, frame and so on are encapsulated with the resin encapsulant while pressing downward the outer periphery side (outer frame) of the signal-connecting leads **12** of the lead frame with the die assembly such that the resin encapsulant **17** does not reach the lower surface side of the convex portion **13a** of the die pad **13** and the back surface sides of the signal-connecting leads **12**.

Finally, the seal tape **21**, which has been attached to the lower surface of the convex portion **13a** of the die pad **13** and the back surfaces of the signal-connecting leads **12**, is

peeled off and removed. Thus, the back surface side of the die pad **13** has a structure in which only the lower part of the convex portion **13a** thereof protrudes downward from the back surface of the resin encapsulant, and the external electrodes **18** protruding from the back surface of the resin encapsulant **17** is formed. Furthermore, the outer periphery sides of the signal-connecting leads **12** are cut off to be substantially flush with the side faces of the resin encapsulant **17**, thereby completing a resin-molded semiconductor device such as that shown in FIG. **1**.

According to the manufacturing method of this embodiment, a resin-molded semiconductor device, where only part of the convex portion **13a** of the die pad **13** protrudes from the back surface of the resin encapsulant **17** existing under the flange portion **13b** and around the convex portion **13a** of the die pad **13**, can be manufactured easily.

In addition, in accordance with the manufacturing method of this embodiment, since the seal tape **21** is attached in advance to the lower surface of the convex portion **13a** of the die pad **13** and the back surfaces of the signal-connecting leads **12** before the resin encapsulation step, the resin encapsulant **17** cannot reach, and no resin burr is formed on, the respective back surfaces of the convex portion **13a** of the die pad **13** and the signal-connecting leads **12** functioning as external electrodes. Thus, it is not necessary to remove

resin burr that might have been formed on the lower surface of the convex portion **13a** of the die pad **13** or the external electrodes **18** using water jet or the like, unlike a conventional method for manufacturing a resin-molded semiconductor device with the lower surfaces of signal-connecting leads entirely exposed. That is to say, since this troublesome step of removing resin burr can be omitted, this process is simple enough to mass-produce a great number of resin-molded semiconductor devices. In addition, peeling of metal plated layers such as nickel (Ni), palladium (Pd), and gold (Au) on the lead frame and deposition of impurities, which might happen during the conventional process step of removing resin burr using water jet or the like, can be eliminated. This is why the lead frame can be plated in advance with these respective metal layers before the resin encapsulation process.

It should be noted that, although the step of removing resin burr using water jet can be omitted, the step of attaching the seal tape should be additionally performed. However, the step of attaching the seal tape **21** is more cost-effective than the water jet process step, and it is easier to control the former process step than the latter process step, thus simplifying the process without fail. Among other things, the method of this embodiment is particularly advantageous to the manufacturing process in that attaching

the seal tape can eliminate the water jet process step, which has been necessary in the prior art and has brought about various quality-control problems like peeling of plated layers from the lead frame and deposition of impurities, thus preventing the plated metal layers from peeling off. Also, even if resin burr is formed depending on, for example, the attachment state of the seal tape, the resulting resin burr is very thin, and can be easily removed through a water jet process performed at a low water pressure; therefore, peeling of the metal plated layers can be prevented, thus making it possible for the lead frame to be plated with these metal layers beforehand.

It should be noted that level differences are formed between the convex portion **13a** of the die pad **13** and the back surface of the resin encapsulant **17** and between the respective back surfaces of the signal-connecting leads **12** and the resin encapsulant **17** as shown in FIG. **6** because during the resin encapsulation process, the seal tape **21** softens and thermally shrinks owing to the heat applied from a die assembly for encapsulation, and the convex portion **13a** of the die pad **13** and the signal-connecting leads **12** are strongly forced into the seal tape **21**. Accordingly, in this structure, since the convex portion **13a** of the die pad **13** and the signal-connecting leads **12** protrude from the back surface of the resin encapsulant **17**, the standoff height of the

convex portion **13a** of the die pad **13** and the protrusion heights (the standoff heights) of the external electrodes **18**, or the lower parts of the signal-connecting leads **12**, can be secured. For example, in this embodiment, since the thickness of the seal tape **21** is 50 μ m, the protrusion heights may be about 20 μ m. As can be understood, by adjusting the thickness of the seal tape **21**, the height of the protruding portion of each external electrode **18** measured from the back surface of the resin encapsulant can be maintained within an appropriate range. This means that the standoff height of each external electrode **18** can be controlled only by adjusting the thickness of the seal tape **21**, that is, there is no need to separately provide means or step for controlling the standoff height, which is extremely advantageous to mass production in terms of the process control cost. The thickness of the seal tape **21** is preferably in the range from about 10 μm to about 150 μm.

It should be noted that, as the seal tape **21**, any material having predetermined hardness, thickness, and thermal softening properties may be selected in accordance with a desired protrusion height.

It is to be noted that, in the first embodiment, the standoff heights of the convex portion of the die pad **13** and the external electrodes **18** may also be adjusted by regulating the pressure applied onto the seal tape **21**. For example, the

standoff heights may be set at approximately zero. In such a case, the resin encapsulant **17** thickly exists under the flange portion **13b** surrounding the convex portion **13a** of the die pad **13** at its back surface side, thus bringing the advantage that the resin encapsulant **17** is able to hold the die pad **13** even more strongly.

(SECOND EMBODIMENT)

Hereinafter, the second embodiment of the present invention will be described. The fundamental structure of the resin-molded semiconductor device of this embodiment is the same as that of the first embodiment shown in FIG. **1**, except for the shape of the die pad. Thus, in this embodiment, only the shape of the die pad will be described, and the description of the other members will be omitted.

- FIRST SPECIFIC EXAMPLE -

FIG. **7(a)** is a plan view of a die pad **13** according to a first specific example of this embodiment, while FIG. **7(b)** is a cross-sectional view taken along the line **VIIb-VIIb** in FIG. **7(a)**. As shown in FIGS. **7(a)** and **7(b)**, the die pad **13** of this specific example is provided with small, circular through holes **30a** at the four corner portions thereof. It is to be noted that these through holes **30a** are formed outside of a region where the semiconductor chip **15** is mounted.

Furthermore, no convex portion is formed at the back surface side of the die pad **13**. Optionally, a convex portion may be formed thereon.

In the resin-molded semiconductor device in the first specific example of this embodiment, the through holes **30a** are formed in the die pad **13**; therefore, by filling these through holes **30a** with the resin encapsulant, the force of the resin encapsulant **17** holding the die pad **13** considerably improves. And the adhesion between the die pad **13** and the resin encapsulant **17**, in consequence, increases to enable the prevention of penetration of water, moisture, or the like through the boundary between the die pad **13** and the resin encapsulant **17**, thus improving the moisture resistance of the device.

In this example, resin encapsulation is performed during the process of manufacturing the resin-molded semiconductor device while a seal tape may be attached to the lower surface of the die pad **13** as in the first embodiment, thus eliminating the leakage of the resin encapsulant from the through holes. Actually, in accordance with a conventional resin encapsulation method, if through holes are provided in a die pad not covered with a resin encapsulant but exposed, then the resin encapsulant passes through the through holes to leak out of the back surface side of the die pad. In addition, since no pressure is applied onto the die pad

through a die assembly for encapsulation, a larger amount of resin encapsulant leaks out of the back surface side of the die pad as compared with the back surface sides of the signal-connecting leads, and as a consequence the product value of such a device might be lost. Accordingly, apart from a device in which a die pad is buried in a resin encapsulant, there has been the inconvenience of difficulty in applying such a structure that through holes are provided for the die pad to a resin-molded semiconductor device of the type in which the back surface of the die pad is not covered with a resin encapsulant but exposed. In contrast, in this embodiment, since a method in which resin encapsulation is performed with the seal tape adhered to the back surface of the die pad is used, the provision of the through holes **30a** for the die pad **13** can increase the holding force of the resin encapsulant without causing any inconvenience.

It should be noted that elliptical through holes **30b** may be provided instead of circular ones as shown in FIG. **8** illustrating a modified example. In such a case, since the cross-sectional area of each through hole **30b** is larger than that of the circular one, the force of the resin encapsulant **17** holding the die pad **13** increases even more.

It should be noted that, the semiconductor chip **15** may have such a large size as to hang over the die pad **13**.

Also, even when blind holes, not through holes, are

formed, the effect of increasing the holding force of the resin encapsulant **17** still can be obtained.

- SECOND SPECIFIC EXAMPLE -

FIG. **9(a)** is a plan view of a die pad **13** according to a second specific example of the second embodiment, while FIG. **9(b)** is a cross-sectional view taken along the line **IXb-IXb** in FIG. **9(a)**. As shown in FIGS. **9(a)** and **9(b)**, the die pad **13** of this specific example is formed at the four corner portions thereof with stepped through holes **30c** each of which has a lower part larger in diameter. These through holes **30c** are formed outside of a region where the semiconductor chip **15** is mounted. Also, the structure in this example and that of the die pad **13** of the first embodiment are the same in that a convex portion is formed at the back surface side of the die pad **13** by half etching or the like, but the through holes **30c** are formed in the convex portion in this example.

In the resin-molded semiconductor device in the second specific example of this embodiment, the stepped through holes **30c**, each having a lower part larger in diameter, are provided for the die pad **13**, thus considerably increasing the force of the resin encapsulant **17** holding the die pad **13**.

It should be noted that elliptical through holes **30d** may be provided instead of circular ones as shown in FIG. **10** illustrating a modified example. In such a case, since the

cross-sectional area of each through hole **30d** is larger than that of the circular one, the force of the resin encapsulant **17** holding the die pad **13** further increases. In particular, where each of the elliptical through holes **30d** is formed to have a elongate shape, a larger area can be secured for the die pad **13** to be surrounded by these through holes **30d**, and as a consequence the restriction on the size of a semiconductor chip to be mounted can be relaxed. In other words, the size of a resin-molded semiconductor device, applicable to a semiconductor chip of the same size, can be reduced.

It should be noted that, the through holes **30c** or **30d** are not necessarily provided outside of the region where the semiconductor chip **15** is mounted. However, in that case, the through holes **30c** or **30d** are preferably formed in a region that the resin encapsulant **17** can reach from the back surface side of the die pad **13**, i.e., a region surrounding the convex portion.

Also, if a structure in which a semiconductor chip is flip-chip bonded to the die pad with bumps interposed therebetween is used, the resin encapsulant never fails to reach the inside of the through holes wherever these holes may be by providing gaps between the semiconductor chip and the die pad. Accordingly, there is no restriction on the locations of the through holes as a matter of principle.

Furthermore, the semiconductor chip **15** shown in FIG. **9** and FIG. **10** may be a size large enough to hang over the through holes **30c** or **30d**.

(THIRD EMBODIMENT)

FIG. **11(a)** is a plan view of a resin-molded semiconductor device according to the third embodiment, while FIG. **11(b)** is a cross-sectional view taken along the line **XIb-XIb** in FIG. **11(a)**. It is to be noted that, in FIG. **11(a)**, the resin encapsulant **17** is illustrated as being transparent, the semiconductor chip **15** is supposed to have an outline indicated by the broken lines, and the metal fine wires **16** are omitted in the drawing.

As shown in FIGS. **11(a)** and **11(b)**, the resin-molded semiconductor device of this embodiment includes a lead frame including: signal-connecting leads **12**; a die pad **13** for supporting a semiconductor chip thereon; and support leads **14** for supporting the die pad **13**. Further, a semiconductor chip **15** is bonded onto the die pad **13** with an adhesive, and electrode pads (not shown) of the semiconductor chip **15** are electrically connected to the signal-connecting leads **12** with metal fine wires **16**. Furthermore, the signal-connecting leads **12**, die pad **13**, support leads **14**, semiconductor chip **15**, and metal fine wires **16** are encapsulated within a resin encapsulant **17**. Also, the inner peripheral region of each

signal-connecting lead **12** at the lower surface side thereof is half etched. Stated otherwise, the region of each signal-connecting lead **12** that is not half-etched constitutes a convex portion.

Now, the feature of the resin-molded semiconductor device of this embodiment will be described. The die pad **13** is down set by depressed portions **19** of the support leads **14** so as to be located below the signal-connecting leads **12**. Also, no resin encapsulant **17** exists on the back surface side of the die pad **13** and the lower surface side of the convex portion of each signal-connecting lead **12**. That is to say, the back surface of the die pad **13** is exposed to be a heat-radiating face, the lower surface of the convex portion of each signal-connecting lead **12** is also exposed, and the lower part of the signal-connecting lead **12**, including the lower surface of the convex portion thereof, functions as an external electrode **18**. This structure can easily be formed by performing resin encapsulation with the seal tape adhered to the respective lower surfaces of the die pad **13** and the signal-connecting leads **12** as described in the first embodiment. Further, no resin burr, which is ordinarily part of the resin sticking out during the resin encapsulation step, exists on the back surface of the die pad **13** and on the external electrodes **18**, and the die pad **13** and the external electrodes **18** slightly protrude downward from the back surface of the resin

encapsulant **17**. Such a structure where the die pad **13** and the external electrodes **18** protrude downward and no resin burr exists can be easily formed by performing resin encapsulation with the seal tape adhered to the respective lower surfaces of the die pad **13** and the signal-connecting leads **12** as described in the first embodiment.

In the resin-molded semiconductor device of this embodiment, since the die pad **13** is down set to be located below the signal-connecting leads **12** (or the external electrodes **18**), the effects to be described below can be attained.

FIG. **12** is a cross-sectional view illustrating the state where the resin-molded semiconductor device of this embodiment is mounted on a motherboard **40**. As shown in FIG. **12**, electrodes **41** and heat-radiating pad **42** on the motherboard **40** are aligned and soldered with external electrodes **18** and die pad **13** of the resin-molded semiconductor device, respectively. In such a case, since the thickness of solder **43a** interposed between the external electrodes **18** and the electrodes **41** is different from that of solder **43b** interposed between the die pad **13** and the heat-radiating pad **42**, the tension applied between the external electrodes **18** and the electrodes **41** is different from that applied between the die pad **13** and the heat-radiating pad **42**. As can be understood, the tension of solder in the center of

the resin-molded semiconductor device is different from that in the periphery thereof, and as a consequence the self alignment of the resin-molded semiconductor device can be improved with respect to the motherboard **40**, thus mounting the resin-molded semiconductor device at a more accurate position in a shorter amount of time.

Also, since the die pad **13** having a larger area is strongly bonded onto the heat-radiating pad **42** of the motherboard **40** in the center region of the resin-molded semiconductor device, various stresses are applied between the external electrodes **18** and the electrodes **41** after the bonding. Thus, the connection of the signal-connecting leads **12**, which is often broken when the lower surface thereof is exposed, can be stabilized, and the reliability of the device can be improved as a whole.

It should be noted that, in this embodiment, the lower surface of the die pad **13** is located below the lower surfaces of the external electrodes **18**. However, the device can be self-aligned with improved accuracy even if the level relationship between these surfaces is inverted. Nevertheless, if the lower surface of the die pad **13** is below that of the external electrode **18**, then the gap between the die pad **13** and the heat-radiating pad **42** is smaller and the tension increases in that broad region, and as a consequence the above effects can be attained more remarkably.

(FOURTH EMBODIMENT)

Hereinafter, the fourth embodiment of the present invention will be described. In this embodiment, description will be made about specific examples for suppressing deformation of the die pad **13** during the step of performing resin encapsulation in which a seal tape is placed under the lead frame as in the first embodiment.

- FIRST SPECIFIC EXAMPLE -

FIG. **13(a)** is a plan view of a lead frame according to a first specific example of this embodiment, while FIG. **13(b)** is a cross-sectional view of the lead frame taken along the line **XIIIb-XIIIb** in FIG. **13(a)**. As shown in FIGS. **13(a)** and **13(b)**, support leads **14** are provided to extend from the four corner portions of the die pad **13** and be connected to an outer frame **46**, and each of these support leads **14** is provided with a U-shaped bent portion **45** functioning as a spring. Also, the lower surface of the die pad **13** is lower than that of the outer frame **46**, that is, a predetermined level difference exists between these members.

If the lower surface of the die pad **13** is located below that of the outer frame **46** this way, pressure can also be applied from the die pad **13** onto a seal tape that is attached to the lower surface of the lead frame during the resin

encapsulation step. Specifically, since a die cavity exists over the die pad **13**, clamping force applied between the upper and lower dies of a die assembly for encapsulation cannot be satisfactorily transmitted to the die pad **13** in such a case. Thus, the effect, as described in the first embodiment, of protruding the lower part of the die pad **13** from the back surface of the seal tape by forcing the die pad **13** into the seal tape, might be weakened. In contrast, in this specific example, the lower surface of the die pad **13** is located below that of the outer frame **46**; therefore, when a clamping force is applied through the die assembly for encapsulation to the outer frame **46**, pressure is applied through support leads **14** to the die pad **13** to force the die pad **13** into the seal tape, thus securing a great protrusion height of die pad **13** from the resin encapsulant **17**. Also, by providing the bent portions **45** for the support leads **14** of the lead frame, the deformation of each support lead **14** is absorbed at its bent portion **45**, thus suppressing the deformation of the die pad **13**.

It should be noted that, in the configuration shown in FIG. **13(b)**, the die pad **13** is located lower than the U-shaped bent portions **45**, because the entire lead frame is inclined. Alternatively, the die pad **13** may be lowered by providing level differences on both sides of each U-shaped bent portion **45**.

- SECOND SPECIFIC EXAMPLE -

FIG. **14(a)** is a plan view of a lead frame according to a second specific example of this embodiment, while FIG. **14(b)** is a cross-sectional view taken along the line **XIVb-XIVb** in FIG. **14(a)**.

As shown in FIGS. **14(a)** and **14(b)**, in the lead frame of this specific example, support leads **47** are interposed between the die pad **13** and the signal-connecting leads **12** connected to the outer frame **46**. In other words, the lead frame is configured to make the outer frame **46** support the die pad **13** via the support leads **47** and the signal-connecting leads **12**. Also, each of these support leads **47** is provided with a U-shaped bent portion **48** to function as a spring. It is to be noted that, in this embodiment, part of the back surface of each signal-connecting lead **12** is half etched, while the remaining part, not half etched, constitutes a convex portion. Furthermore, at the surface side of each signal-connecting lead **12**, two grooves are formed to extend vertically to the direction in which the signal-connecting lead **12** extends.

FIGS. **15(a)** and **15(b)** are cross-sectional views illustrating part of the process for manufacturing a resin-molded semiconductor device using this lead frame.

First, as shown in FIG. **15(a)**, a semiconductor chip **15**

is mounted to the die pad **13**, and the electrode pads of the semiconductor chip **15** are connected, with metal fine wires **16**, to the signal-connecting leads **12** at the part thereof interposed between the two grooves. And a seal tape **21** is attached to the die pad **13** of the lead frame.

Next, as shown in FIG. **15(b)**, the lead frame and the semiconductor chip **15** are introduced into a cavity between upper and lower dies **50a, 50b** of a die assembly **50** for encapsulation, and then clamping force is applied to the outer frame **46** of the lead frame between the upper and lower dies **50a, 50b**. And when the outer frame **46** is pressed by the clamping force, the pressure is transmitted to the die pad **13**, located below the outer frame **46**, via the signal-connecting leads **12** and the support leads **48**. Accordingly, not only the die pad **13** is forced into the seal tape **21** but also the convex portion of each of the signal-connecting leads **12** and the outer frame **46** are forced into the seal tape **21** as well. By pouring the resin encapsulant **17** into the die cavity of the die assembly **50** for encapsulation in such a state, the die pad **13**, the signal-connecting leads **12** and so on are encapsulated within the resin encapsulant **17**.

It should be noted that, in this specific example, the portion of the die assembly for encapsulation, corresponding to the die pad **13**, is also formed to be slightly lower than the portion thereof corresponding to the outer frame **46** (and

the signal-connecting lead **12**). Thus, although the level difference between the die pad **13** and the outer frame **46** (and the signal-connecting lead **12**) decreases to a large degree after the resin encapsulation, the lower surface of the die pad **13** is still located lower than the outer frame **46**.

Subsequently, after the resin encapsulation step is finished, the seal tape **21** is peeled off from the encapsulated members, and then the connection between the outer frame **46** and the signal-connecting leads **12** is cut off to remove the outer frame **46**, thereby obtaining a resin-molded semiconductor device, in which the die pad **13** and the convex portion (external electrode) of each of the signal-connecting leads **12** are not covered with the resin encapsulant but exposed.

In this specific example, since the support leads **47** are provided between the signal-connecting leads **12** and the sides of the die pad **13**, the clamping force applied to the outer frame **46** can be transmitted more effectively to the die pad **13** than the first specific example, thus realizing, with more certainty, a structure in which the lower surface of the die pad **13** is not covered with the resin encapsulant but exposed.

Also, in the resin-molded semiconductor device completed, since the lower surface of the die pad **13** is located below the respective lower surfaces of the signal-connecting leads **12**, the effect of improving the self-

alignment as described above is also obtained.

- THIRD SPECIFIC EXAMPLE -

If the support leads **47** are provided between the signal-connecting leads **12** and the sides of the die pad **13** as in the second specific example, the use of the signal-connecting leads **12**, connected to the support leads **47**, for signal transmission sometimes causes inconveniences depending on the type of a component formed in the semiconductor chip **15** (e.g., a bipolar transistor). Thus, in this embodiment, contrivances for avoiding such inconveniences will be described.

FIG. **16** is a cross-sectional view illustrating part of a lead frame during the resin encapsulation step for a resin-molded semiconductor device in this specific example. In this specific example, part of the support leads **47** is not covered with a resin encapsulant but exposed. That is to say, the lead frame is configured in such a shape that a rising portion **49** of each bent portion **48** of the support lead **47** is forced into the seal tape **21** within a die assembly for encapsulation. And after the resin encapsulation step is finished, the rising portion **49** is cut off with laser light or the like as indicated by the broken lines in FIG. **16**. Cutting off part of the support lead **47** in this way creates a state in which the signal-connecting lead **12** connected to the

support lead **47** is electrically disconnected from the die pad **13**; therefore, even when the signal-connecting lead **12** is used for signal transmission, no inconvenience is caused. On the other hand, since these members have already been encapsulated with the resin encapsulant, the support leads **47** have already played their roles; therefore, such cutting causes no inconvenience, either. Also, if the support leads **47** each of which can still function as a spring are left as they are after the resin encapsulation step, the reliability of the device might deteriorate because residual stress exists in the resin encapsulant. However, in this example, such inconvenience can be avoided with certainty.

It should be noted that after the resin encapsulation step is finished, the rising portion **49** of each support lead **47** may be cut off together with the seal tape **21**, while the tape **21** is still attached to the lead frame. In such a case, since the region surrounding the cut portion is covered with the seal tape **21**, even if some part molten by the laser light is scattered around, the scattered part can be advantageously removed easily from the resin-molded semiconductor device by peeling off the seal tape **21**.

- FOURTH SPECIFIC EXAMPLE -

If part of each support lead **47** is cut as in the third specific example, it may be assumed that such a cutting is

troublesome. Thus, in this specific example, a contrivance for facilitating cutting of the support leads will be described.

FIG. **17** is a cross-sectional view illustrating part of a lead frame according to a fourth specific example. As shown in FIG. **17**, a rising portion **49** of a support lead **47** of this specific example is provided at the surface side thereof with a notch.

In this specific example, since the rising portion **49** of the support lead **47** is provided with a notch, the work of cutting the rising portion **49** with laser light or the like after the resin encapsulation step is finished can be performed easily and rapidly.

As described in each of the foregoing specific examples, in a resin-molded semiconductor device obtained by the manufacturing process according to each of the specific examples of the present embodiment, the die pad **13** and signal-connecting leads **12** are partially not covered with the resin encapsulant but exposed as in the resin-molded semiconductor device shown in FIG. **1**. In particular, since a level difference is provided between the outer frame and the die pad in each of these specific examples of the present embodiment, a clamping force applied to the outer frame can be transmitted through the support leads to the die pad without fail so that the die pad can be forced into the seal

tape, thus obtaining, with certainty, a structure in which the lower part of the die pad is not covered with the resin encapsulant but exposed.

Also, even when the lower surface of the die pad should be located below that of each of the signal-connecting leads as in the third embodiment, remarkable effects can be attained by employing the support lead structure according to this embodiment as shown in respective drawings of this embodiment.

It should be noted that, in this embodiment, a structure, in which a convex portion like that shown in FIG. **1** is formed in the die pad **13** and only this convex portion is not covered with the resin encapsulant but exposed, can also be employed. Such a structure is preferred in that the resin encapsulant **17** can hold the die pad **13** more strongly in such a case.

(FIFTH EMBODIMENT)

In this embodiment, description will be made about a resin encapsulation method for adjusting the protrusion height of the die pad from the resin encapsulant.

FIG. **18** is a cross-sectional view illustrating the resin encapsulation step in the manufacturing process of a resin-molded semiconductor device according to this embodiment. As shown in FIG. **18**, a die assembly for encapsulation,

consisting of an upper die **50a** and a lower die **50b**, is used, a semiconductor chip **15** is mounted onto a die pad **13**, the electrode pads of the semiconductor chip is connected to signal-connecting leads **12** with metal fine wires **16**, these connected members are placed onto the lower die **50b** of the die assembly for encapsulation, and then resin encapsulation is performed with the seal tape **21** adhered to the lower surface of the lead frame.

Now, the manufacturing method of this embodiment is characterized in that first concave clearance portions **52** are formed in regions of the lower die **50b**, each facing the signal-connecting lead **12** (and the outer frame **46**) of the lead frame, and a second concave clearance portion **53** is formed in a region of the lower die **50b** facing the die pad **13**.

The clearance portions **52** and **53** are provided like this for the die assembly for encapsulation to make the seal tape **21** enter these clearance portions **52** and **53**, thereby reducing the extent to which the signal-connecting leads **12** and the die pad **13** are forced into the seal tape **21**. As a result, the heights of the portions to be protruded can be adjusted at desired values based on not only the clamping force applied to the die assembly for encapsulation but also the depths of the clearance portions **52**, **53**, thereby minimizing the formation of resin burr.

(SIXTH EMBODIMENT)

In this embodiment, description will be made about a resin encapsulation method for securing higher protrusion height of the die pad from the resin encapsulant.

FIG. **19** is a cross-sectional view illustrating the resin encapsulation step in the manufacturing process of a resin-molded semiconductor device according to this embodiment. As shown in FIG. **19**, a die assembly for encapsulation, consisting of an upper die **50a** and a lower die **50b**, is used, a semiconductor chip **15** is mounted onto a die pad **13**, the electrode pads of the semiconductor chip are connected to signal-connecting leads **12** with metal fine wires **16**, these connected members are placed onto the lower die **50b** of the die assembly for encapsulation, and then resin encapsulation is performed with the seal tape **21** adhered to the lower surface of the lead frame.

Now, the manufacturing method of this embodiment is characterized in that the seal tape **21** is provided with a through hole **25** at a region thereof located under the die pad **13** and that the lower die **50b** is provided with a suction hole **54** at a region thereof facing the die pad **13**. The through hole **25** of the seal tape **21** is larger in diameter than the suction hole **54** of the lower die **50b**, thus facilitating the positioning control of the suction hole **54** to be aligned with

the through hole **25**. Furthermore, the suction hole **54** is formed to communicate with a vacuum device, and the suctorial function of the vacuum device absorbs the die pad **13** toward the suction hole **54**, thereby increasing the extent to which the die pad **13** is forced into the seal tape **21**.

In accordance with the method of this embodiment for manufacturing a resin-molded semiconductor device, by providing the through hole **25** and the suction hole **54** for the seal tape **21** and the die assembly for encapsulation, respectively, the extent to which the die pad **13** is forced into the seal tape **21** increases. Accordingly, even a die pad **13** having a large area, to which the clamping force is hard to be satisfactorily transmitted through the die assembly for encapsulation, can be protruded from the resin encapsulant much higher.

It is to be noted that the method of this embodiment is naturally applicable to not only the die pad but also any member if it needs to be protruded without fail from the resin encapsulant.

(OTHER EMBODIMENTS)

In each of the foregoing embodiments, the electrode pads of the semiconductor chip and the signal-connecting leads are connected to each other with metal fine wires. However, the connection members of the present invention are not limited

to the metal fine wires. For example, depending on the embodiment, a resin-molded semiconductor device may be formed by encapsulating a semiconductor chip, which has been flip-chip mounted on a substrate via bumps interposed therebetween, within a resin encapsulant.

It should be noted that, if a hole used for vacuuming is provided for a die assembly to perform resin encapsulation while absorbing the seal tape **21** with the vacuum pressure, formation of wrinkles on the seal tape can be suppressed and the back surface of the resin encapsulant can be flattened.

[Effects of the Invention]

In a first lead frame according to the present invention, a convex portion protruding downward and a flange portion surrounding the convex portion are formed at the lower surface side of a die pad. Accordingly, it is possible to perform resin encapsulation with the lower surface of the convex portion of the die pad not covered with a resin encapsulant but exposed, while making the resin encapsulant exist under the flange portion of the die pad, thereby improving, in the resin-molded semiconductor device, the force of the resin encapsulant holding the die pad and the reliability by suppressing the penetration of water or the like.

In a second lead frame according to the present invention, a die pad is provided with a through hole.

Accordingly, by making a resin encapsulant exist also inside the through hole when resin encapsulation is performed, the force of the resin encapsulant holding the die pad and the moisture resistance of the device can be improved.

In a third lead frame according to the present invention, in addition to locating a die pad below an outer frame, support leads are interposed between the die pad and the outer frame. Accordingly, when resin encapsulation is performed, a clamping force, applied through a die assembly for encapsulation onto the outer frame, can be applied to the die pad with certainty, and the protrusion height of the die pad can be secured by forcing the die pad into a seal tape.

In a fourth lead frame according to the present invention, the lead frame has a structure in which a die pad is located below an outer frame, and support leads are interposed between signal-connecting leads and the die pad. Accordingly, when resin encapsulation is performed, a clamping force, applied through a die assembly for encapsulation onto the outer frame, can be transmitted to the die pad with more certainty, thereby attaining the effect of the third lead frame remarkably.

In a first resin-molded semiconductor device according to the present invention, the first lead frame and a semiconductor chip mounted over the lead frame are used, and the lower surface of a die pad is exposed while other portion

thereof is buried in a resin encapsulant. Accordingly, the force of the resin encapsulant holding the die pad is increased and the moisture resistance of the device can be improved.

In a second resin-molded semiconductor device according to the present invention, the lower surface of a die pad is not covered with a resin encapsulant but exposed, and the die pad is provided with a through hole. Accordingly, the force of the resin encapsulant holding the die pad is increased and the moisture resistance of the device can be improved.

In a third resin-molded semiconductor device according to the present invention, a die pad and each signal-connecting lead are partially not covered with a resin encapsulant but exposed, and the lower surface of the die pad is located at a level different from that of the lower surface of the signal-connecting lead. Accordingly, when the semiconductor device is mounted on a motherboard, the time taken to realize the self alignment can be shortened and the positional accuracy can also be improved, that is, the mountability of the device can be improved.

In a fourth resin-molded semiconductor device according to the present invention, the device has a structure in which a die pad and each signal-connecting lead are partially not covered with a resin encapsulant but exposed, and each support lead can partially function as a spring. Accordingly, during

resin encapsulation, the deformation of the support lead can be absorbed while a clamping force, applied through a die assembly for encapsulation to an outer frame, can be applied to the die pad with certainty, thereby securing the standoff height of the die pad, for example.

In a fifth resin-molded semiconductor device according to the present invention, the device has a structure in which a die pad and signal-connecting leads are partially not covered with a resin encapsulant but exposed, and support leads are interposed between the die pad and the signal-connecting leads. Accordingly, when resin encapsulation is performed, a clamping force, applied through a die assembly for encapsulation to an outer frame, can be applied to the die pad with certainty, thereby remarkably attaining the effect of the fourth resin-molded semiconductor device.

In a first method of manufacturing a resin-molded semiconductor device according to the present invention, a die pad and signal-connecting leads are partially not covered with a resin encapsulant but exposed, and the lower surface of the die pad is located at a level lower than the lower surfaces of the signal-connecting leads. Accordingly, it is possible to form a resin-molded semiconductor device that can be self-aligned desirably when it is mounted onto a motherboard.

In a second method of manufacturing a resin-molded

semiconductor device according to the present invention, a die pad and signal-connecting leads are partially not covered with a resin encapsulant but exposed, support leads are interposed between the die pad and the signal-connecting leads, and the support leads are partially cut off. Accordingly, it is possible to form a resin-molded semiconductor device in which any signal-connecting leads can be used for signal connection.

In a third method of manufacturing a resin-molded semiconductor device according to the present invention, a die assembly for encapsulation including a suction hole and a seal tape including a through hole positioned over the suction hole are used, and resin encapsulation is performed while sucking portions to be protruded through the suction hole and the through hole. Accordingly, it is possible to form a resin-molded semiconductor device in which the desired portions are sufficiently protruded from a resin encapsulant.

In a fourth method of manufacturing a resin-molded semiconductor device according to the present invention, resin encapsulation is performed using a seal tape that has a thickness in the range from $10\mu m$ to $150\mu m$ on portions not to be covered with a resin encapsulant. Accordingly, a resin-molded semiconductor device in which the desired portions are protruded from the resin encapsulant can be formed.

[Brief Explanation of the Drawings]

[FIG. **1**]

A cross-sectional view of a resin-molded semiconductor device according to the first embodiment of the present invention where the resin encapsulant is illustrated as being transparent.

[FIG. **2**]

A cross-sectional view illustrating the step of preparing a lead frame during the process of manufacturing the resin-molded semiconductor device of the first embodiment.

[FIG. **3**]

A cross-sectional view illustrating the step of bonding a semiconductor chip onto a die pad during the process of manufacturing the resin-molded semiconductor device of the first embodiment.

[FIG. **4**]

A cross-sectional view illustrating the step of forming metal fine wires during the process of manufacturing the resin-molded semiconductor device of the first embodiment.

[FIG. **5**]

A cross-sectional view illustrating the step of placing a seal tape under the lead frame during the process of manufacturing the resin-molded semiconductor device of the first embodiment.

[FIG. **6**]

A cross-sectional view illustrating the resin encapsulation step during the process of manufacturing the resin-molded semiconductor device of the first embodiment.

[FIG. **7**]

Plan view and cross-sectional view of a lead frame according to a first specific example of the second embodiment of the present invention.

[FIG. **8**]

A plan view of a lead frame according to a variant of the first specific example of the second embodiment of the present invention.

[FIG. **9**]

Plan view and cross-sectional view of a lead frame according to a second specific example of the second embodiment of the present invention.

[FIG. **10**]

A plan view of a lead frame according to a variant of the second specific example of the second embodiment of the present invention.

[FIG. **11**]

Plan view and cross-sectional view of a resin-molded semiconductor device according to the third embodiment of the present invention.

[FIG. **12**]

A cross-sectional view illustrating the state in which

the resin-molded semiconductor device of the third embodiment is mounted on a motherboard.

[FIG. **13**]

Plan view and cross-sectional view of a lead frame according to a first specific example of the fourth embodiment of the present invention.

[FIG. **14**]

Plan view and cross-sectional view of a lead frame according to a second specific example of the fourth embodiment of the present invention.

[FIG. **15**]

Cross-sectional views illustrating parts of the process for manufacturing a resin-molded semiconductor device using the lead frame according to the second specific example of the fourth embodiment of the present invention.

[FIG. **16**]

A drawing illustrating part of a lead frame in the resin encapsulation step for a resin-molded semiconductor device according to a third specific example of the fourth embodiment of the present invention.

[FIG. **17**]

A drawing illustrating part of a lead frame in the resin encapsulation step for a resin-molded semiconductor device according to a fourth specific example of the fourth embodiment of the present invention.

[FIG. **18**]

A cross-sectional view illustrating the resin encapsulation step in the manufacturing process of a resin-molded semiconductor device according to the fifth embodiment of the present invention.

[FIG. **19**]

A cross-sectional view illustrating the resin encapsulation step in the manufacturing process of a resin-molded semiconductor device according to the sixth embodiment of the present invention.

[FIG. **20**]

A cross-sectional view of a conventional resin-molded semiconductor device of the type including external electrodes on its back surface side.

[Explanation of the Reference Characters]

12 signal-connecting lead

13 die pad

14 support lead

15 semiconductor chip

16 metal fine wire

17 resin encapsulant

18 external electrode

21 seal tape

25 through hole

30 through hole

40 motherboard

41 electrode

42 heat-radiating pad

43 solder

45 bent portion

46 outer frame

47 support lead

48 bent portion

49 rising portion

50a upper die

50b lower die

52 first clearance portion

53 second clearance portion

54 suction hole

[Name of the Document] Abstract

[Abstract]

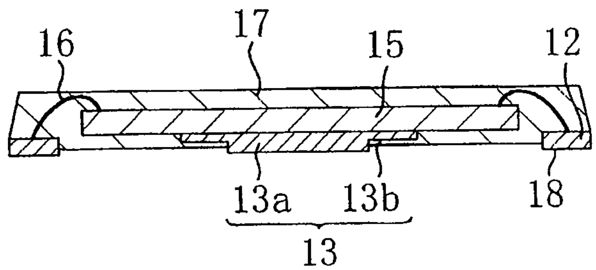
[Purpose] To improve the characteristic of a resin-molded semiconductor device in which a die pad is not covered with the back surface of a resin encapsulant but exposed.

[Solution] A lead frame including signal-connecting leads **12**, a die pad **13**, and support leads is provided. Further, a semiconductor chip **15** is bonded onto the die pad **13** with an adhesive, and electrode pads of the semiconductor chip **15** and the signal-connecting leads **12** are electrically connected to each other with metal fine wires **16**. Furthermore, these members are encapsulated in a resin encapsulant **17**. The back surface side of the die pad **13** is subjected to half etching or the like to form a convex portion **13a** and a flange portion **13b** surrounding the convex portion. Since the resin encapsulant **17** thinly exists under the flange portion **13b**, the resin encapsulant can hold the die pad **13** more strongly and the moisture resistance of the device can be improved while protruding the lower surface of the die pad from the resin encapsulant **17**.

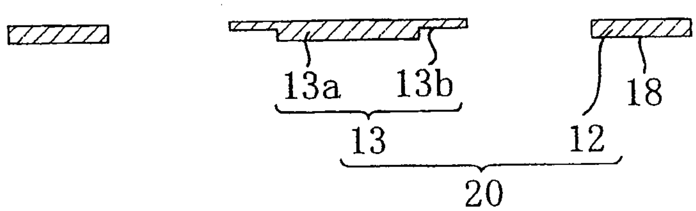
[Selected Figure] FIG. **1**

【書類名】　図面　[Name of the Document] DRAWINGS

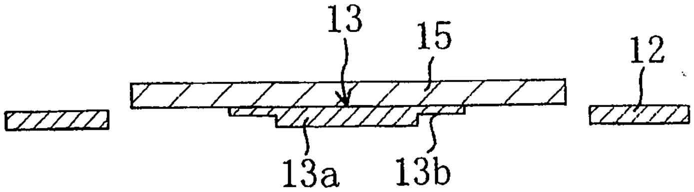
【図１】 [FIG.1]



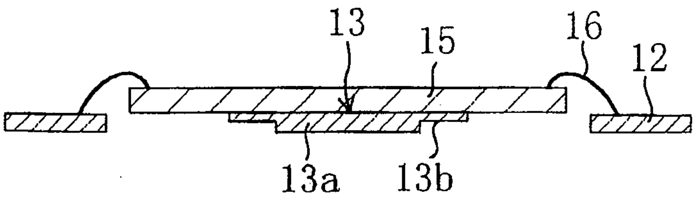
【図２】 [FIG.2]



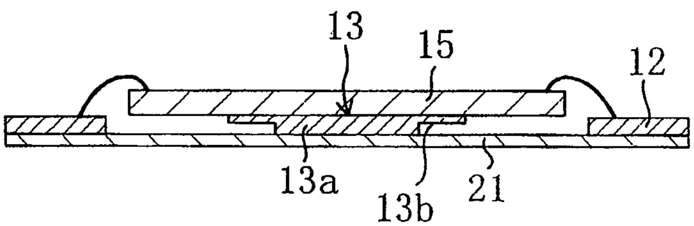
【図３】 [FIG.3]



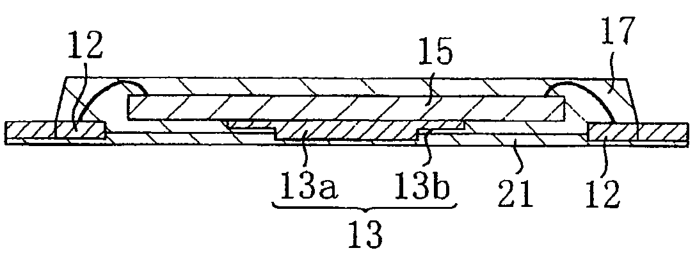
【図４】 [FIG. 4]



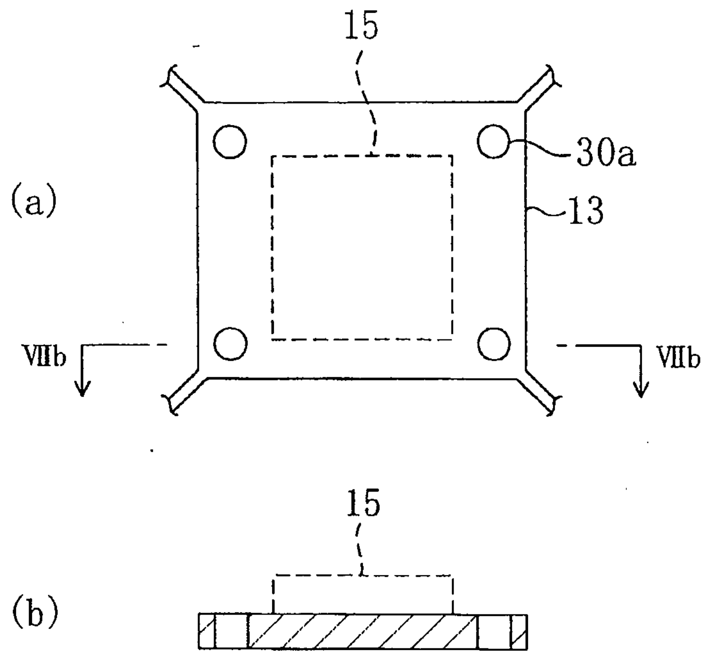
【図５】 [FIG. 5]



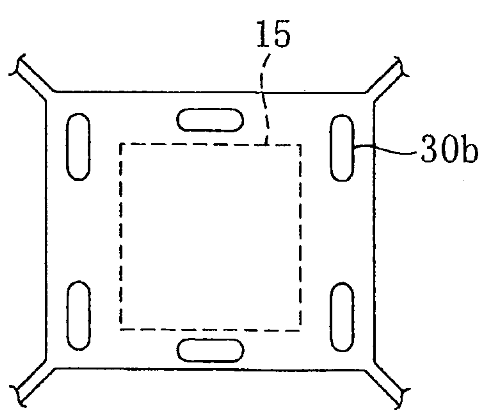
【図６】 [FIG. 6]



【図７】 [FIG.7]

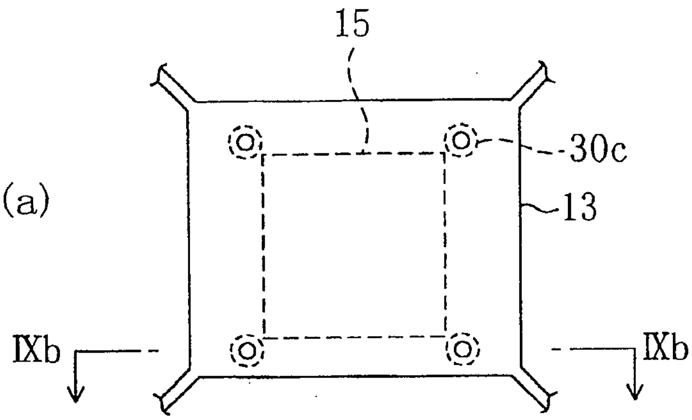


【図８】 [FIG.8]

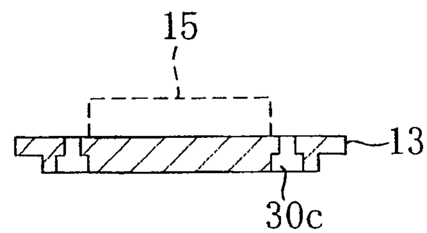


【図９】 [FIG.9]

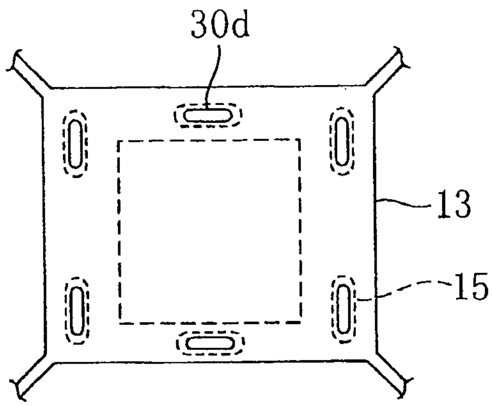
(a)



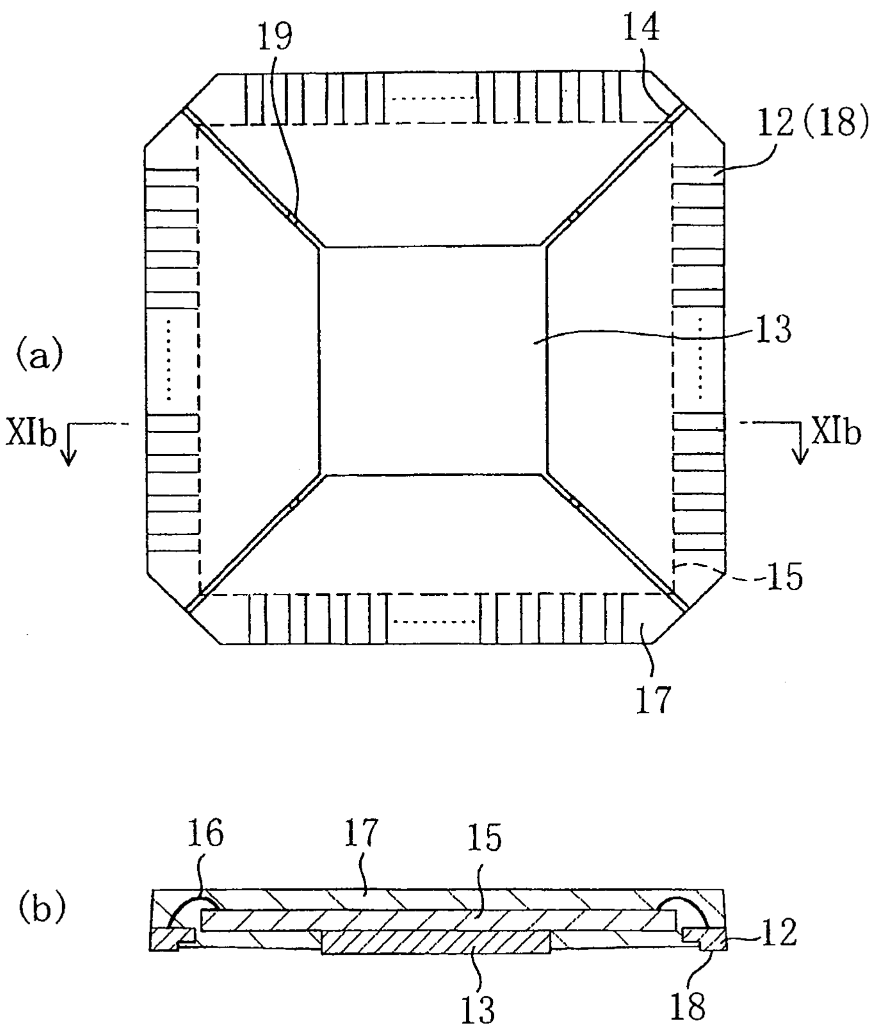
(b)



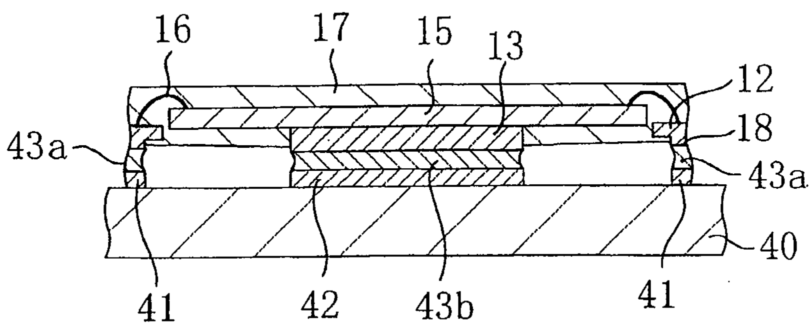
【図１０】〔FIG.10〕



【図１１】 [FIG. 11]

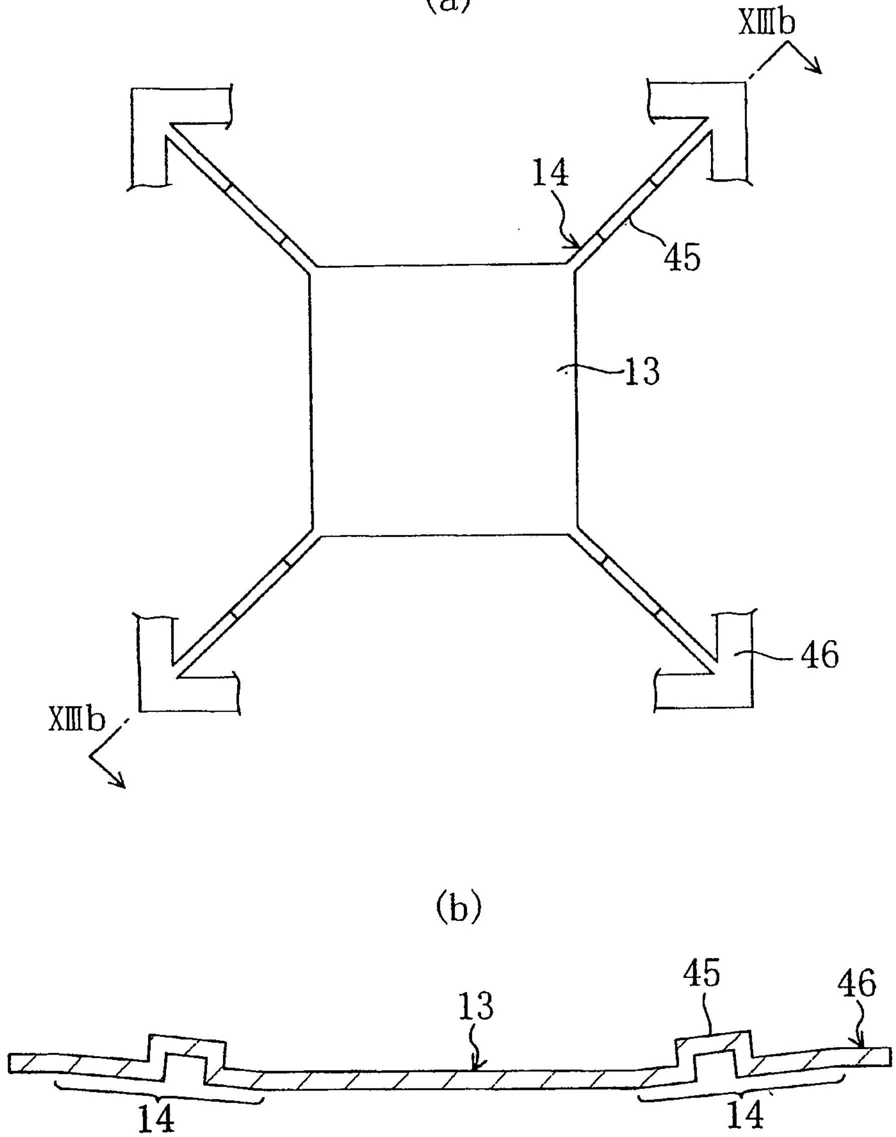


【図１２】 (FIG.12)



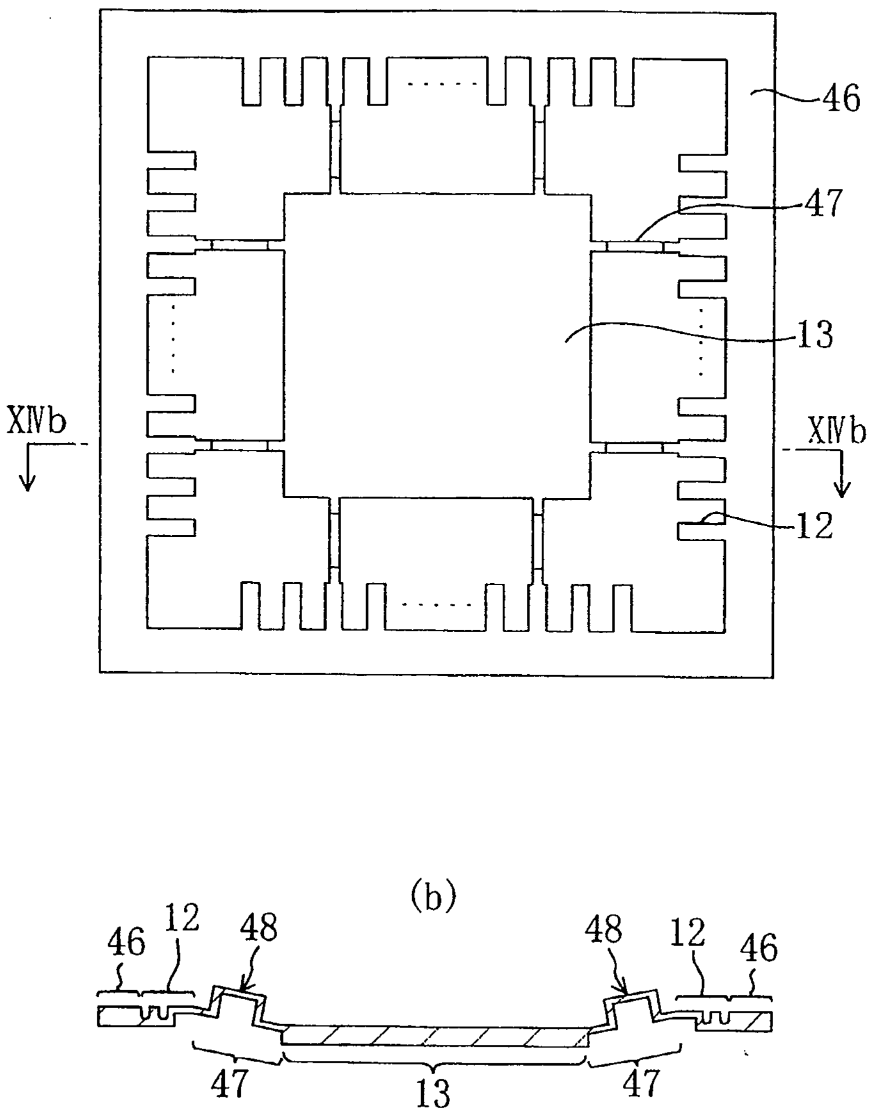
【図１３】 [FIG.13]

(a)

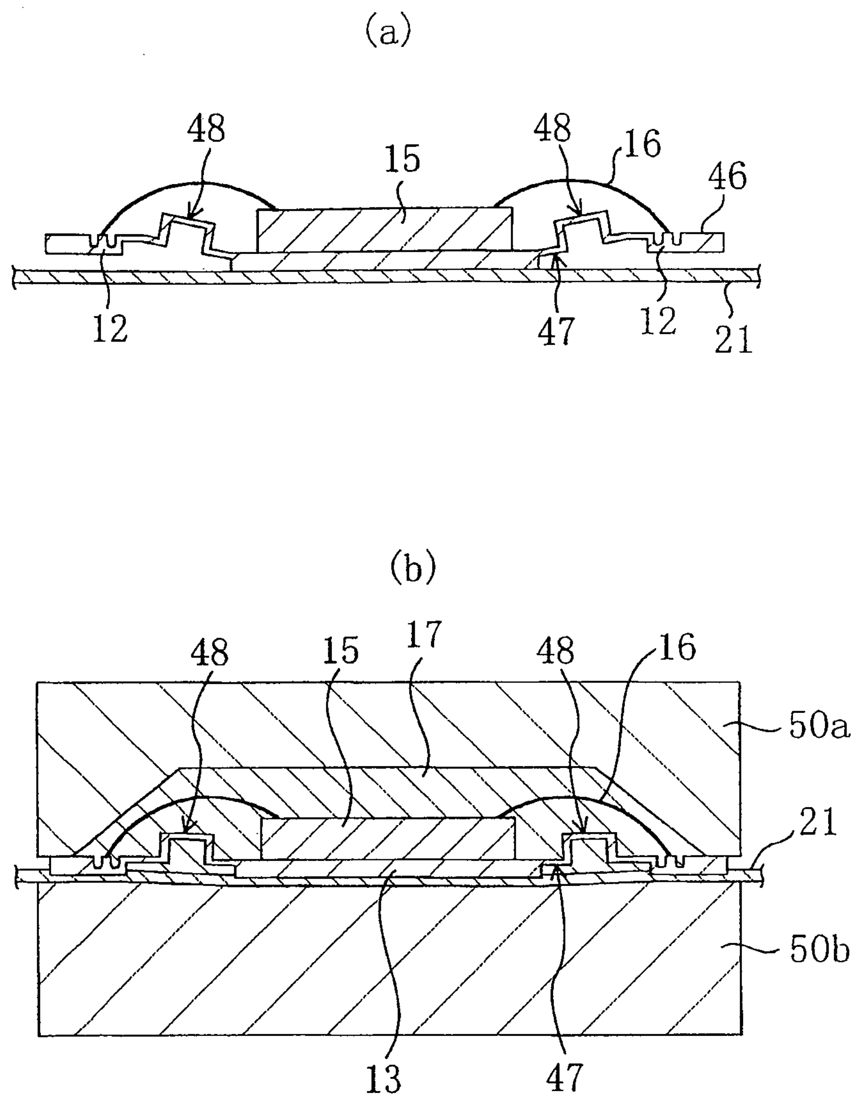


【図１４】 [FIG.14]

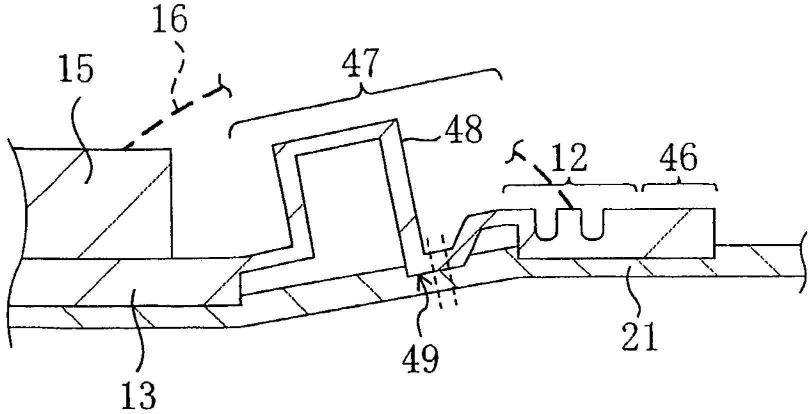
(a)



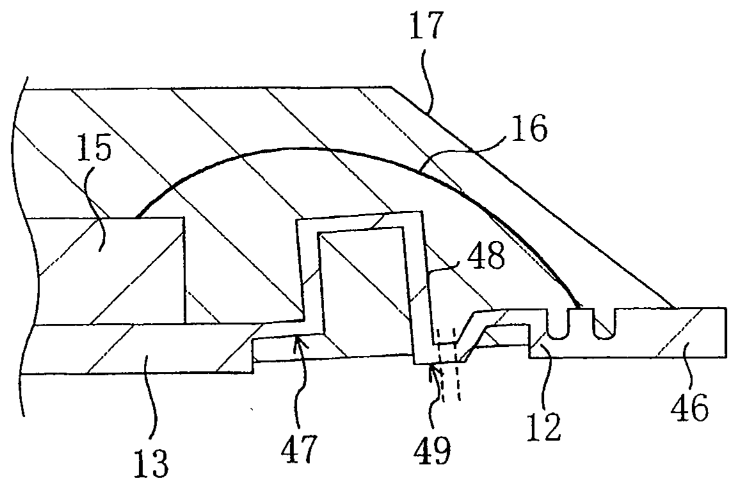
【図１５】 (FIG.15)



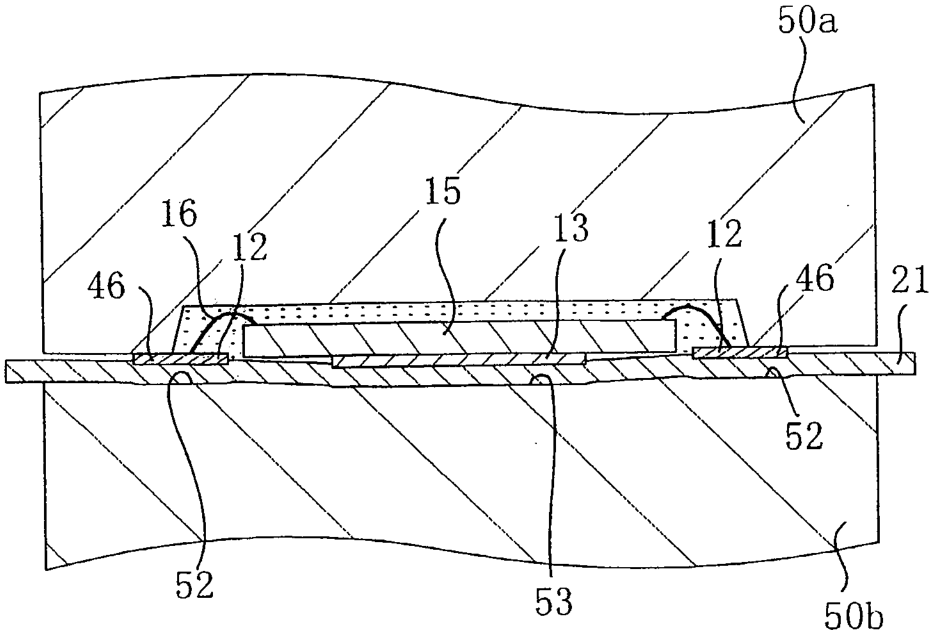
【図１６】〔FIG.16〕



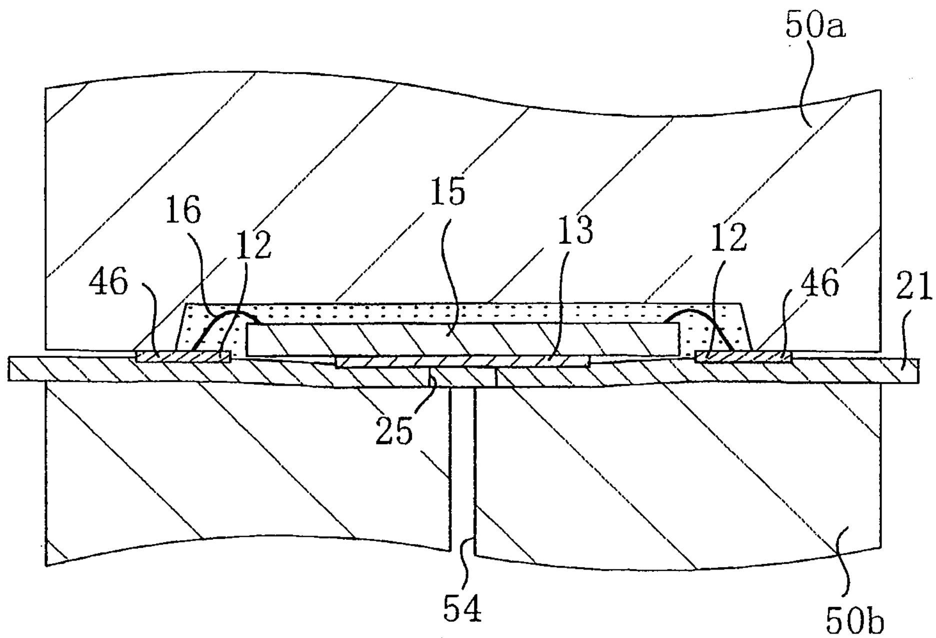
【図１７】〔FIG.17〕



【図１８】[FIG. 18]



【図１９】 [FIG.19]



【図２０】 [FIG.20]